A structured approach to assessing and developing integrated project delivery: capability maturity and readiness evaluation

by

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Une approche structurée pour l'évaluation et le développement de la réalisation intégrée de projet: évaluation de la maturité et de la préparation des capacités

Ahmad J. ARAR

RÉSUMÉ

Les pratiques intégrées et les modèles de livraison sont de plus en plus considérés comme la voie à suivre pour l'industrie de la construction afin de maximiser la valeur générée et d'augmenter la probabilité de réussite des projets. En particulier, la Réalisation de Projet Intégrée (RPI) est une manière innovante de livraison de projet qui se détache des pratiques de livraison traditionnelles et est jugée efficace pour intégrer les parties prenantes, permettre la collaboration et améliorer les résultats des projets. En tant qu'approche relativement nouvelle, le cadre et les pratiques de la RPI manquent encore de pièces essentielles pour permettre le plein potentiel de cette méthode de livraison, ce qui constitue les principales motivations de cette recherche. Sur le plan théorique, les motivations découlent du domaine de recherche éparpillé et de l'absence d'un cadre de recherche et développement largement reconnu qui définit les parties constituantes de la RPI et fait le pont entre le travail académique et les implications pratiques qui entravent le développement ultérieur de cette approche. D'autre part, les motivations pratiques proviennent du manque d'outils structurés permettant une évaluation éclairée des pratiques de la RPI aux différentes étapes d'un projet, ce qui est jugé nécessaire pour améliorer ses pratiques et faciliter l'amélioration continue.

Par conséquent, l'objectif central de la recherche présentée dans cette thèse de doctorat est d'améliorer le fondement théorique et les mises en œuvre pratiques de la RPI, construisant ultimement un chemin pour des approches plus standardisées et cohérentes de la mise en œuvre de la RPI, améliorant ainsi son efficacité et favorisant son adoption à travers l'industrie. Cet objectif a été atteint grâce à des progrès de recherche qui comprennent l'établissement d'un cadre de recherche et développement pour la RPI aux côtés du développement de modèles de maturité et de préparation de capacités. Le Cadre de Recherche et Développement (IPD R&D) définit les éléments constituants de la RPI et les organise dans un cadre qui correspond à sa mise en œuvre pratique. Il consolide également les efforts de recherche éparpillés, organisant le domaine de recherche et développement autour de la RPI, et guide les enquêtes académiques futures et l'exploration pratique de la RPI. De plus, cette recherche introduit une approche structurée pour évaluer et améliorer les pratiques de la RPI en développant des modèles doubles : un Modèle de Maturité RPI et un Modèle de Préparation RPI, chacun adapté pour évaluer et améliorer l'efficacité des pratiques de la RPI à différentes étapes du projet. Le Modèle de Maturité de Capacité (IPDCMM) et son outil sont conçus pour informer et évaluer la maturité des pratiques de la RPI à la fin du projet, fournissant aux projets et aux équipes des informations précieuses sur l'efficacité de leur mise en œuvre à travers un ensemble d'indicateurs et de métriques pour cinq niveaux de maturité, dérivés à la fois de cadres établis et de données empiriques de trois études de cas de la RPI.

Parallèlement, le Modèle de Préparation de Capacité (IPDCRM) et son outil évaluent la préparation du projet à commencer la mise en œuvre de la RPI, en s'assurant que les plans critiques, les ressources, les outils et les efforts nécessaires sont en place et alignés pour une mise en œuvre réussie de la RPI. Ce modèle définit les indicateurs clés de préparation, qui sont évalués contre une liste de contrôle structurée pour déterminer le niveau de préparation parmi cinq niveaux établis et guider les projets dans l'alignement et l'amélioration de leur préparation.

Le cadre méthodologique général qui a guidé cette recherche était la Recherche en Science de Conception (DSR), soutenue par une philosophie pragmatique qui forme la base épistémologique et ontologique à la fois de l'approche et des résultats de cette étude. La philosophie pragmatique a influencé l'approche de recherche et dirigé les choix méthodologiques, privilégiant les méthodes de recherche basées sur leur praticité et leur flexibilité. Elle met l'accent sur l'obtention de résultats pratiques et applicables, à savoir des artefacts, qui profitent à l'industrie de la construction. Ce cadre de recherche embrasse une interaction dynamique entre théorie et données empiriques, itérant systématiquement entre le développement, le test et le raffinement des modèles.

Selon cette approche méthodologique, cette étude utilise une collecte de données à méthodes mixtes à travers cinq études de cas canadiennes dans quatre provinces canadiennes qui offrent une diversité dans le type de projet, la taille et les juridictions impactant l'adoption de la RPI. Cette diversité a fourni une base empirique solide pour valider les modèles et outils proposés. Cette recherche contribue au domaine de la livraison de projets et de la gestion de la construction en étendant la compréhension théorique de la RPI à travers une approche structurée de la recherche et du développement, de la capacité, de la maturité et de la préparation. De plus, elle contribue à l'application pratique de la RPI en opérationnalisant ces cadres en outils pratiques qui peuvent permettre une évaluation éclairée des pratiques de la RPI, améliorer sa mise en œuvre et faciliter l'amélioration continue. Cette recherche se conclut par un appel à une validation plus poussée des outils proposés à travers des segments industriels plus larges pour garantir leur généralisabilité et pour continuer à faire avancer les pratiques collaboratives et innovantes au sein de l'industrie de la construction.

Mots-clés: réalisation de projet intégrée, recherche et développement, modèle de maturité de capacité RPI, modèle de préparation de capacité RPI, collaboration

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ABSTRACT

Integrated practices and delivery models are increasingly being seen as the way forward for the construction industry to maximize the value generated and increase the likelihood of project success. Most prominently, Integrated Project Delivery (IPD) is an innovative way of project delivery that breaks away from traditional delivery practices and is deemed effective in integrating stakeholders, enabling collaboration, and enhancing project outcomes. As a relatively novel approach, the IPD framework and practices still lack essential pieces to enable the full potential of this delivery method, which, in turn, represents the motivations for this research. Namely, the theoretical motivations stem from the scattered research domain, and the absence of a widely recognized research and development framework that defines the constitute parts of IPD and bridges the academic work with practical implications which hinder further development in this approach. The practical motivations, on the other hand, derive from the lack of structured tools that enable an informed evaluation of IPD practices at the different stages of a project, which is deemed necessary for enhancing its practices and facilitating continuous improvement.

Therefore, the central aim of the research presented in this PhD dissertation is to enhance the theoretical foundation and practical implementations of IPD, ultimately constructing a path for more standardized and consistent approaches to IPD implementation, thus enhancing its effectiveness and fostering its adoption across the industry. This aim was achieved through research progress that includes establishing a research and development framework for IPD alongside the development of capability maturity and readiness models. The Research and Development Framework (IPD R&D) defines the constituted elements of IPD and organizes them in a framework that corresponds to its practical implementation. It also consolidates scattered research efforts, organizing the research and development domain around IPD, and guides future scholarly inquiry and practical exploration in IPD. In addition, this research introduces a structured approach for evaluating and enhancing IPD practices by developing dual models: an IPD Maturity Model and an IPD Readiness Model, each tailored to evaluate and enhance the effectiveness of IPD practices at different project stages. The Capability Maturity Model (IPDCMM) and its tool are designed to inform and assess the maturity of IPD practices at the end of the project, providing projects and teams valuable insights into the effectiveness of their implementation through a set of indicators and metrics for five levels of maturity, derived from both established frameworks and empirical data from three IPD case studies.

Concurrently, the Capability Readiness Model (IPDCRM) and its tool evaluate project readiness to start implementing IPD, ensuring that critical plans, resources, tools, and necessary efforts are in place and aligned for a successful IPD implementation. This model identifies key readiness indicators, which are evaluated against a structured checklist to determine the readiness level among five established levels and guide projects in aligning and enhancing their preparedness.

The overarching methodological framework that guided this research was Design Science Research (DSR), underpinned by a pragmatic philosophy that forms the epistemological and ontological basis for both the approach and the findings of this study. The pragmatic philosophy influenced the research approach and directed the methodological choices, prioritizing research methods based on their practicality and flexibility. It emphasizes achieving practical and applicable results, namely artifacts, that benefit the construction industry. This research framework embraces a dynamic interaction between theory and empirical data, systematically iterating between model development, testing, and refinement.

Through this methodological lens, this study employs mixed-methods data collection across five Canadian case studies in four Canadian provinces that offer diversity in project type, size, and jurisdictions impacting IPD adoption. This richness provided an empirical base to validate the proposed models and tools. This research contributes to the field of project delivery and construction management by extending the theoretical understanding of IPD through a structured approach to research and development, capability, maturity, and readiness. In addition, it contributes to the practical application of IPD by operationalizing these frameworks into practical tools that can enable informed evaluation of IPD practices, enhance its implementation, and facilitate continuous improvement. This research concludes with a call for further validation of the tools proposed across broader industry segments to ensure their generalizability and to continue advancing collaborative and innovative practices within the construction industry.

Keywords: integrated project delivery, research and development, IPD capability maturity model, IPD capability readiness model, collaboration

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PPP	Public-Private Partnerships
IPD	Integrated Project Delivery
DSR	Design Science Research
DBB	Design-Bid-Build
CMR	Construction Management at Risk
DB	Design-Build
SMT	Senior Management Team
PMT	Project Management Team
PIT	Project Integration Team
LPDS	Lean project delivery systems
CAGR	Compound Annual Growth Rate
IPDCMM	IPD Capability Maturity Model
IPD-MAT	IPD Maturity Assessment Tool
IPDCRM	IPD Capability Readiness Model
IPD-ReAT	IPD Readiness Assessment Tool
CSCE	Canadian Society of Civil Engineers Conference
SQI	Société Québécoise des Infrastructures
IDT	Innovation of Diffusion Theory

INTRODUCTION

The construction industry forms a significant part of the global economy, and it plays a driving role in development and growth. Despite its critical role, the industry continues to grapple with inefficiencies that hinder the full realization of its potential. The construction sector faces persistent challenges characterized by frequent project delays, cost overruns, fragmented operations, and conflicts among stakeholders, among others (Azis et al., 2012; Doloi, 2013; Mohd Nawi et al., 2014; Riazi et al., 2020). These issues underscore the complexity and dynamic nature of the industry, which involves numerous stakeholders and variables that can affect project outcomes in different ways, emphasizing the need for a shift towards collaboration practices as a potential solution to these long-standing inefficiencies (Atkinson et al., 2022; Fulford & Standing, 2014; Suprapto et al., 2015).

Historically, the construction industry has been slow to adopt innovations due to the resistance to change and the established business models (K.-M. White & Clarkson, 2024). Compared to other industries, construction has struggled to keep pace with evolving demands, particularly in adopting collaborative delivery models. In response, the industry has recently begun to shift toward more collaborative approaches. Innovations, such as design-build, public-private partnerships (PPP), Alliancing, Partnering, and Integrated Project Delivery (IPD), have been developed to improve construction practices and outcomes by enhancing operational efficiency through collaboration (Fulford & Standing, 2014; Engebø, Lædre, et al., 2020).

At the forefront of these innovations, IPD emerges as a transformative approach designed in contrast to the most common practices within the industry. According to the American Institute of Architects AIA (2007) and the Canadian Construction Documents Committee CCDC 30 (2018), IPD is defined as a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. Unlike traditional project delivery methods that often operate in silos, IPD fosters a true partnership where risks and rewards are shared, and collective objectives drive project delivery (H. Ashcraft, 2022a; Kent & Becerik-Gerber, 2010). This partnership aims to leverage the collective expertise of project members to enhance project outcomes and maximize the value to the owner and team members alike. This is ensured through the early engagement of all stakeholders, fostering a collaborative environment, and the multidisciplinary nature of the teams created (Rahim et al., 2015).

The construction industry is increasingly finding value in IPD as it begins to gain traction as an alternative project delivery system that demonstrates the ability to significantly enhance project outcomes (El Asmar et al., 2013; H. Ashcraft, 2014; Kelly & Ilozor, 2020). Despite the increasing amount of evidence supporting the advantages of IPD and its growing adoption (Rashed & Mutis, 2021), the current state of IPD research and practice reveals two critical and interrelated gaps in both theory and practice.

First, despite a growing body of research on IPD, the domain remains fragmented and lacks a unifying structure. Many frameworks have been proposed, but they tend to focus narrowly on either theoretical constructs or practical applications, without offering an integrated view. This has limited the field's ability to accumulate knowledge, coordinate research efforts, and support systematic development. A comprehensive framework that organizes the key components of IPD and bridges theory with practice would be beneficial in providing clarity, consolidating existing work, and enabling more strategic progress in both research and practice.

Second, as IPD continues to evolve, a key challenge has emerged around how its implementation is assessed, guided, and improved. While its principles are widely discussed, there remains a lack of structured tools that formalize critical concepts such as readiness and maturity (Wood et al., 2024). This creates both a practical and a theoretical gap. In practice, the absence of such tools limits the ability to evaluate implementation, compare performance across projects, and support continuous improvement. Theoretically, it restricts efforts to formalize knowledge about how IPD works in real contexts and under what conditions it succeeds.

These gaps form the foundation for the research questions that guide this dissertation:

What are the key characteristics of Integrated Project Delivery (IPD)? How can these characteristics be articulated to organize the research and development domain? How can this articulation enable informed evaluation, consistent implementation, and continuous improvement of IPD?

To answer these questions, the study pursues three main objectives, as illustrated in

Figure 0.1:

- Develop a Research and Development Framework for IPD that bridges theory and practice by identifying, organizing, and articulating key components of IPD in a way that supports both scholarly inquiry and applied development.

- Develop a Capability Maturity Model and Assessment Tool for IPD to enable structured evaluation of IPD practices at the project completion stage, supporting benchmarking, lessons learned, and continuous improvement.

- Develop a Readiness Model and Assessment Tool for IPD to evaluate whether a project is prepared for implementation at the initiation stage, ensuring that all necessary conditions and resources are aligned before project commencement.

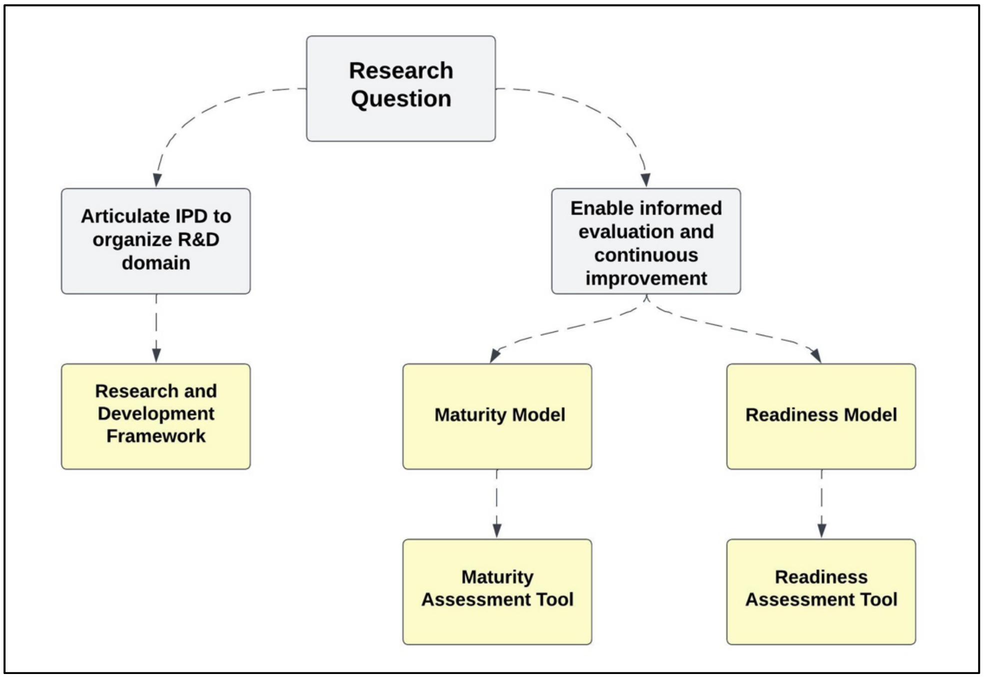

Figure 0.1 Research Contributions and Their Link to the Central Research Questions

This roadmap presents the research approach to address this gap by developing structured models and their corresponding tools to enhance the implementation of IPD. These tools are designed to scale the benefits of IPD and fully harness its transformative potential, facilitating a more standardized and consistent approach to IPD while providing the necessary infrastructure to support its effective application across the construction industry.

These objectives are addressed through three core research contributions, which are developed and presented in three article-based chapters. In addition to the main contributions, a set of secondary outputs provides further insight into the impact and potential of IPD in the construction industry. These components are outlined in Figure 0.2, which presents the main and secondary contributions of the research and their relationship to the structure of the dissertation.

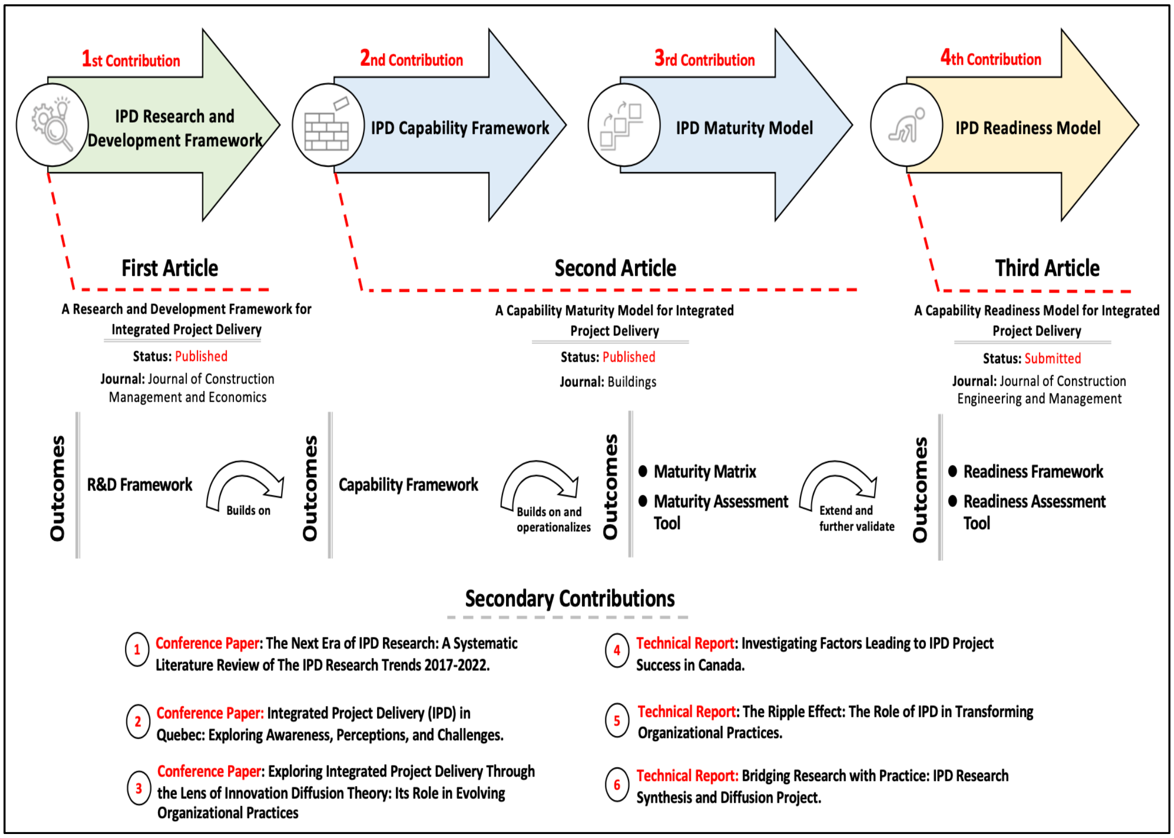

Figure 0.2 Research Main and Secondary Contributions

Underpinned by pragmatic philosophy and guided by a Design Science Research (DSR) approach, this research follows a systematic methodology beginning with problem identification, conceptual model development, and the iterative refinement of their operational tools through validation in multiple case studies (vom Brocke & Maedche, 2019). The process starts with the creation of the IPD R&D Framework to establish a foundational understanding, followed by the development of the Capability Maturity and Readiness Models in subsequent phases. These models are then translated into operational tools for practical use.

This research bridges theoretical insights and practical applications by developing a foundational framework and two conceptual models for IPD, each supported by actionable assessment tools that operationalize the models in practice. Collectively, the framework, models, and tools contribute to the structured advancement of IPD, enabling continuous improvement and supporting its widespread adoption across the construction industry.

This article-based dissertation begins with a research motivation, methodology, and key contributions chapter that outlines the practical and theoretical motivation of the study, identifies the problem statement and research questions, and delves into the details of the methodology and approach followed. The following chapters present the three main contributions of this research: Article 1, Article 2, and Article 3. This is followed by a discussion about how this research answered the research questions and how each part of the research contributes to the overall objective. This is followed by a conclusion chapter summarizes the research findings, highlighting its limitations and future work. Additionally, a list of supplementary materials is included, such as the full version of the Maturity Tool and Readiness Tool, the Maturity Assessment report prepared for one of the case studies, the Readiness Assessment Report prepared for another case study, and annexes that include a set of secondary contributions in the form of other journal and conference papers, and industry reports that were part of the outcomes of this research.

CHAPTER 1

RESEARCH MOTIVATION, METHODOLOGY, AND KEY CONTRIBUTIONS

1.1 Introduction

This chapter outlines the foundation upon which the research in this dissertation is based. It offers a detailed picture of the study's practical and theoretical motivations while emphasizing the identified research gaps. The problem statement is then introduced, followed by defining the research question and objectives. The subsequent sections elaborate on the research approach and methodology used. Lastly, the study's main and secondary contributions are outlined, and the overall structure of the thesis is presented.

1.2 Practical Motivation

The practical motivations of this research stem from my experience regarding the current challenges within the construction industry and my evolving belief that there should be a different path for a more effective, collaborative, supportive, and less adversarial way of conducting business within the industry.

Three key moments have significantly shaped my motivation to pursue an alternative approach to traditional construction delivery systems. Initially, my background as an engineer in the construction industry spanned over eight years in various roles, during which I had the privilege to work and experience different perspectives as a general contractor, subcontractor, owner's representative, and briefly at an engineering firm. This exposure provided me with a comprehensive view of the construction sector. Adding to this, I obtained my credentials as a certified Project Management Professional (PMP) in 2015, equipping myself with the latest advancements in the project management field. As I assumed increasing responsibilities, I gradually realized how difficult it is to change the entrenched practices within an industry characterized by a non-collaborative, adversarial culture with frequent conflicts and inefficiencies.

In the second key moment, this experience influenced my decision when I decided to pursue my master's study in construction engineering. At this stage, I opted to investigate the underlying causes of disputes and inefficiencies that plagued the construction projects. This study deepened my understanding of how prevailing practices and culture impact the sector's performance. However, a significant but disheartening discovery from my research was that most fellow practitioners believe that disputes are inevitable in the construction industry. That corresponded to and reinforced my own experience, which was marked by adversarial, conflict-ridden, and non-collaborative practices that often distracted and prevented achieving the project's main objectives.

The third key moment was my introduction to IPD right at the start of my PhD study. I had the privilege of being involved in a research project early in my PhD, which allowed me to interact closely with numerous industry practitioners in Canada who had experienced IPD. I met more than 40 professionals from three projects across three different Canadian provinces. Through these interviews, I witnessed how projects that adopted IPD were able to deliver ahead of schedule, within or under budget, and with greater value and satisfaction to the owners and the team alike. And on top of all of that, I observed how nearly every one of those I met was happy with their experience. For the first time since I got involved in the construction industry, I saw fellow practitioners describe their project experiences as joyful. They spoke of how these projects recharged them and altered their career perspectives, how the collaborative environment allowed them to make real friends, and how they no longer wished to be part of traditional practices.

All these elements reassured me that this could be the real solution to the construction industry's challenges and offer a genuine path forward with a different way to do things. I saw how IPD breaks down silos, brings people together, and fosters partnership over competitiveness. How it promotes joint management over hierarchical structures, encourages close collaboration, and open communication. These principles of IPD solidified my belief that it is worth pursuing deeper into this approach and the collaborative practices and alternative project delivery systems in general, trying to contribute to the efforts that could make the construction industry more effective, more sustainable, and above all, a place that delivers value for all stakeholders while being a place where people are happy to do their jobs.

1.3 Theoretical Motivation

The theoretical motivations for this research stem from a critical need to continue the efforts to advance and optimize collaboration practices in the construction industry in general and enhance the efficacy of IPD in particular. Despite its demonstrated benefits in driving improved outcomes, IPD is still an underutilized approach, with growing but limited adoption across the industry (Rankohi et al., 2022; Rashed & Mutis, 2021). While many barriers contribute to the challenges of adopting IPD, including resistance to change, a lack of knowledge, legal and contractual hurdles, and limited government support, another critical factor is that IPD remains a relatively new approach. It still lacks essential tools and frameworks to support effective implementation, highlighting the need for ongoing efforts to strengthen its theoretical foundations and enhance its practical application (Bhonde et al., 2020; Rashidian et al., 2022).

This section establishes the theoretical motivation for this research by addressing several key questions. Why is IPD relevant? How is it transforming the construction industry? What are the theoretical foundations that shape our understanding of IPD? What is the current state of its implementation and adoption? And what gaps remain in both theory and practice?

The section begins by examining why IPD is relevant and worth studying. It analyzes the transformative elements IPD brings to the construction industry. These include contractual, financial, governance, cultural, and technological innovations. Together, these elements position IPD as a promising alternative to traditional delivery models. Next, the section outlines the theoretical foundations of IPD. It draws on systems theory, relational contract theory, and collaboration theory to explain how IPD is conceptually grounded. Finally, the section evaluates the current state of IPD implementation and adoption. It identifies key gaps in existing frameworks and practices, which this research seeks to address.

1.3.1 IPD as a Paradigm Shift in the Construction Industry

Considering how it differs from traditional delivery systems, IPD can be regarded as a revolutionary approach in the construction industry. It challenges conventional practices and offers a framework that contrasts with nearly every established norm in the field. Through its core principles that promote collaboration, risk-sharing, joint management, early stakeholder engagement, trust, and liability waiver, IPD transforms how projects are contracted, managed, and executed (Ashcraft, 2022; Fischer et al., 2014).

Specifically, the shifts introduced by IPD can be observed in several key areas, including contractual, financial, governance, cultural, and innovation.

1.3.1.1 Contractual

The contractual strategies underpinning construction projects typically involve bilateral contracts in the form of separate contracts between two parties, such as the owner and general contractor, the owner and the architect, and the general contractor and the subcontractor. These contracts, usually in the form of fixed-price or cost-plus agreements, are known for fostering competitive and adversarial relationships among stakeholders, as is widely experienced in the industry (Doloi, 2013). In these traditional contracts, a significant risk is placed in one direction, usually aiming to protect the owner's interest by placing the entire risk on the contractor, subcontractor, or other parties involved. Typically, in arrangements such as Design-Bid-Build (DBB) or Construction Management at Risk (CMR), the financial risk is either heavily shouldered by contractors (in fixed-price contracts) or shared with owners to a limited extent (in cost-plus contracts). This approach often prompts project parties to focus on individual benefits and success rather than collective success, and in many cases, it can lead to conflicts and disputes (Ahmed & El-Sayegh, 2020).

In contrast, IPD completely transforms this landscape by promoting a multi-party agreement that binds the owner, general contractor, architect, engineering firms, and sometimes key subcontractors under a single, shared contract. This arrangement introduces three main elements that differentiate IPD contracts from those widely used in traditional project delivery systems (Pishdad-Bozorgi & Srivastava, 2018).

First among these transformative elements is the shared risk and reward, which ensures that all parties stand to benefit from cost savings and are equally penalized for cost overruns. This results in aligned interests among all team members and promotes a unified approach to achieving project objectives, making any party's success or failure the whole project's success or failure (Zhang & Li, 2014). Secondly, IPD contracts often include a liability waiver among the project parties, a feature absent in traditional project delivery systems such as DBB, CMR, or Design-Build (DB). This contributes to building trust among team members, eliminates the risk of litigation, and encourages the team to prioritize problem-solving approaches to project challenges instead of self-protection (Ahmed et al., 2021). Lastly, the IPD contract provides the necessary legal basis for the project to be jointly managed and controlled. This arrangement ensures that all project parties play a significant role in the decision-making process and that the project is collectively managed. This differs greatly from traditional practices, which often promote a hierarchical structure and a single point of management for the project (Ahmed et al., 2021; Jobidon et al., 2018).

1.3.1.2 Financial

The financial management of traditional construction project delivery methods is generally characterized by siloed management and control for each party within the project (Ahmed & El-Sayegh, 2020). These traditional financial models prioritize budget adherence and cost control from the owner’s perspective, often at the expense of potential collective accountability and collaborative problem-solving (Babalola et al., 2024). In contrast, IPD fundamentally transforms financial management in construction projects through a set of principles centered around shared financial interest, transparency, and collective financial control (Elghaish et al., 2020).

As mentioned in the contractual elements, IPD is fundamentally built on a shared risk and reward concept to ensure shared financial interest among the project participants. This is often supplemented by incentive mechanisms that further unit the financial management effort through mechanisms to share savings and penalties. By sharing the financial stakes, IPD encourages all stakeholders to work together to reduce costs, enhance efficiency, and improve overall project outcomes (Ma et al., 2017; Su et al., 2018; Wang et al., 2019).

In an open-book accounting approach, IPD mandates that financial information is transparent and accessible to all concerned parties. Under such a system, IPD project team members enjoy full transparency regarding expenses and financial forecasting. This level of transparency helps to build trust among stakeholders and facilitates collaborative decision-making regarding the financial aspects of the project (Allison et al., 2018).

Unlike traditional models where each party handles financial management independently, IPD promotes a collective approach. This means that financial decisions are made collaboratively, including budgeting, cost management, and financial planning. This approach promotes joint accountability, ensuring that decisions are made based on the project's goals rather than individual financial objectives (Elghaish & Abrishami, 2021).

1.3.1.3 Governance

In most prevalent project delivery systems such as DBB, CRM, and DB, governance structures are typically hierarchical and rigid. The contractual boundaries define roles and responsibilities, often placing decision-making authority primarily in the hands of the project owner or the general contractor. This approach deprives the project of benefiting from the collective capabilities of its members and limits cross-disciplinary collaboration. This isolation in handling responsibilities may hinder effective responses to project challenges and often lead to disputes among project parties (Ahmed & El-Sayegh, 2020; Barati et al., 2015).

Conversely, IPD follows a different governance approach that fosters a collaborative framework that engages multiple disciplines and stakeholders throughout project phases. Through a flexible and inclusive management structure, IPD reduces hierarchical barriers and facilitates open communication and joint decision-making within and between different management layers (Ashcraft, 2022; Cheng et al., 2023).

IPD's management structure features several integrated teams, including the Senior Management Team (SMT), Project Management Team (PMT), and the Project Integration Team (PIT). Each level features a flat structure and is particularly designed to fulfill specific operational roles and facilitate a joint decision-making process. These management layers operate with a level of openness and interconnectedness, representing the joint management approach in IPD projects (Allison et al., 2018; Ashcraft, 2011).

Another crucial aspect of the IPD governance strategy is the joint decision-making process. Unlike traditional methods, where the decision-making process is often exclusive, IPD employs a consensus-driven approach involving all IPD members. Decision-making bodies such as the PMT include representatives from every partner, ensuring decisions reflect a comprehensive understanding of the project's diverse aspects (Ashcraft, 2011; Walker & Lloyd-Walker, 2019).

Additionally, the team formation approach within IPD projects is another distinguishing aspect. Teams are formed to be multidisciplinary teams that collaborate to achieve specific goals. In IPD, this approach becomes strategic through the continuous formation of flexible PITs to address project needs throughout the project phases (Guan, 2018).

The transformative aspects of the governance approach in IPD projects extend to the performance monitoring activities. This includes a broader integration of performance metrics that go beyond traditional measures such as cost, time, and quality, including tracking metrics of team health, stakeholder satisfaction, and feedback on processes, among others, reflecting a broader perspective on the evaluation of project success (Allison et al., 2018; Poirier et al., 2022).

1.3.1.4 Cultural

The project culture within the construction industry is often described as blaming, adversarial, and siloed with limited cross-organizational collaboration. This inherent culture and frequently seen issues are to blame as part of the current challenges the construction industry faces (Bishop et al., 2009; Humphreys et al., 2003). A clear example is the high number of disputes and conflicts arising between the construction parties every year, causing a considerable waste of time and resources (Arcadis, 2021, 2022).

Therefore, cultural transformation should be a central consideration for any project delivery system aiming to improve the construction industry's performance. IPD, in particular, has shown strong potential in this regard by fostering cultural shifts that promote more collaborative, trust-based project environments. Several studies have reported that projects delivered using IPD often experience reduced disputes, improved team morale, and greater stakeholder satisfaction, attributed to its collaborative structure and shared goals (Agbaxode et al., 2020; Aslesen et al., 2018). However, these outcomes may vary depending on the project and team dynamics, as well as the degree of commitment to IPD principles.

This cultural shift can be characterized by a few key aspects representing IPD's cultural transformation:

- **Mutual Respect and Trust**: First among these is the mutual respect and trust IPD fosters among all project participants. Supported by the true partnership characterized by sharing project risks and rewards and liability waiver. In addition, IPD emphasizes respecting the contributions of all team members, regardless of their organizational level or role.

Arrangements, such as no-title zone, where team members are encouraged to drop formal job titles in the big room to promote open and direct communication, are seen in many IPD projects to encourage participation and value contribution in a blame-free environment (Fischer et al., 2017; AIA, 2007; Walker & Lloyd-Walker, 2019).

- **Enhanced Collaboration and Open Communication**: The high collaboration levels and open communication contribute significantly to this culture. This is enabled by working closely in big rooms and having open lines of communication through the encouragement of informal communication channels. Unlike traditional models, where collaboration might be limited to specific phases or tasks, IPD embeds a collaborative spirit throughout the project lifecycle (Fischer et al., 2017; AIA, 2007; Walker & Lloyd-Walker, 2019).

- **Investment in Team Culture**: In IPD projects, a considerable investment in terms of time and resources is placed to create a favorable team culture. This is reflected in the time spent early in the project to create the project values and maintain them throughout the project. In addition to investing in team-building activities, facilitation, and training. These efforts are critical in harmonizing team dynamics and are a testament to the commitment to building a culture that supports project success (Allison et al., 2018; Poirier et al., 2022).

1.3.1.5 Innovation

Adopting and encouraging innovations in general and keeping up with technological advancement, in particular, is one of the inherent issues in the construction industry. The working environment that is usually prevalent within the construction project often discourages deviation from established practices and tends to operate within rigid frameworks (Xue et al., 2014). Typically, the focus will be on minimizing risk rather than fostering innovation, which usually can involve some risk. Adding to this are boundaries between project parties that limit collaboration across disciplines and organizations. This environment can discourage creative solutions and make the integration of new technologies challenging (Lloyd-walker et al., 2014).

On the contrary, IPD creates an environment that embraces innovation and enhances the integration of technologies such as Building Information Modeling (BIM). In order to do this, IPD breaks the traditional barriers that exist between project participants and fosters a culture of close collaboration and open communication. This shift brings teams together and positions them to work more cohesively, a crucial enabler for the integration of new technologies and innovative practices (Leicht & Harty, 2017). The integration of BIM within the project process leverages its use beyond simple digital modeling, unleashing its full potential as a central platform for information sharing and decision-making. This integration is facilitated by IPD's structure, which encourages all stakeholders to engage with the technology, thereby enhancing project visualization, accuracy, and efficiency (Salim & Mahjoob, 2020; Wei et al., 2021).

In addition, the environment created by IPD encourages participation and values contributions and innovation in a blame-free atmosphere. This cultural shift is vital for promoting an innovative mindset among team members, allowing individuals to propose and test new ideas without fearing negative reception. This integrated and supportive environment that focuses on shared goals rather than individual liability helps cultivate a setting where problem-solving and creative thinking are highly encouraged. This enables construction projects to leverage the collective capability of their teams and make construction projects more innovation-friendly (Leicht & Harty, 2017; Love & Walker, 2019).

1.3.2 IPD Theoretical Constructs: Systems, Relational Contract, and Collaboration Perspective

Understanding how IPD works and how it achieves its notable improvements in project outcomes can be reached by examining its foundational theoretical constructs. The interplay of systems, relational contract, and collaboration theories provide unique insights into the structural, contractual, and interpersonal dynamics that define IPD. This theoretical construct can explain how IPD outperforms traditional project delivery, fostering an integrated and collaborative approach to construction projects.

1.3.2.1 IPD in the Lens of Systems Theory

Due to the highly collaborative and integrated nature of IPD, which involves a complex system of stakeholders, processes, and their interactions, Systems Theory can provide a vital framework for understanding these operational dynamics that explain, in part, the effectiveness of IPD (Hoorn et al., 2019). While projects are generally viewed as complex systems, whether in IPD or traditional delivery settings, IPD uniquely leverages this complexity to foster higher integration, collaboration, and innovation, resulting in a fundamentally more interconnected and dynamic approach (Bertelsen, 2003; Hoorn et al., 2019).

Through its principles, IPD facilitates a profound integration of all project components from the outset. This approach establishes a collaborative environment supported by aligned parties and interdependent disciplines (Malaeb & Hamzeh, 2022). This level of collaboration and integration results in a cohesive project system that allows for dynamic interactions between project components rather than isolation and ensures a seamless flow of knowledge and resources across all project phases (Rankohi et al., 2022). This complex yet compelling framework aligns closely with the systemic concept of holism and interdependency.

Moreover, Systems Theory emphasizes the dynamic and adaptable qualities as inherent characteristics of a well-designed system. Effective systems should be capable of evolving in response to changing conditions (Adams, 2012; Mele et al., 2010). In this context, systems theory can explain how the contractual and organizational frameworks of IPD are structured to support such flexibility. IPD projects are designed to be dynamic and can evolve responsively to meet project demands. IPD includes several mechanisms reflecting this flexibility and adaptability, such as a flexible decision-making process that can include all the IPD members or shrink down whenever needed and the agility in removing and adding new members to the team (Hoorn et al., 2019). In addition to the flexibility in forming and dismantling PITs and the feedback loops IPD applies to maintain its practices and values consistently throughout the project duration, IPD ensures being responsive to immediate product needs (Allison et al., 2018).

Another aspect where systems theory can articulate why IPD often achieves high levels of efficiency and is capable of fostering innovation is the synergy between system components. Systems theories emphasize that continuous interaction between system components and the collective capability and knowledge can produce what individual parties cannot (Adams, 2012; Mele et al., 2010). In this regard, IPD is structured to capitalize on this aspect by fostering an environment where collective efforts of all stakeholders can emerge through intensive collaboration and integration, resulting in innovative solutions in many cases, often beyond the reach of fragmented systems, as in the traditional product delivery systems (Love & Walker, 2019).

1.3.2.2 IPD in the Lens of Relational Contract Theory

Reviewing IPD through the lens of Relational Contract Theory provides crucial insights into the contractual and relational dynamics of IPD and understanding how it enables effective partnerships that deliver better project outcomes (Piroozfar et al., 2019; Salim & Mahjoob, 2020; Wei et al., 2021). The Relational Contract Theory emphasizes that contracts should be fair and trust-based and should feature reciprocity of benefits. In addition, relational contracts should be the basis for long-term relations rather than short-term transactional ones and be flexible to allow for adjustments in response to changing circumstances (Feinman, 1999; Macneil, 1999). This theoretical framework helps articulate why IPD, which employs relational contracts, can enhance project management and outcomes, fostering sustained trust-based relationships among project participants who are aligned in their interests and committed to the collective success of the project (Zhang et al., 2020).

In particular, IPD integrates these norms into the contract and operationalizes them through collaborative practices that ensure all parties are committed to the project's success. This is ensured through a multi-party contract that features shared risk and reward mechanisms, adhering to the concept of reciprocity of benefits in relational contracting theory. In addition, IPD contracts are inherently established on mutual trust, equality, and valuing of team members' contributions, regardless of their size to the project (Abd El-Moneim et al., 2017; Zhang et al., 2020).

Another important aspect of the Relational Contracting Theory is the need for contracts to be flexible to accommodate changes due to uncertain circumstances that could happen during the project. In this context, IPD contracts are regarded as being flexible compared to the traditional form of contracts (Nwajei, 2021). This flexibility can be noticed in several mechanisms, such as having an early validation phase that includes an initial contract to validate the project's feasibility and develop its goals. Also, this flexibility is reflected in the agreement terms that are based on unit prices and agreed-upon percentage of profit/risk-taking, in addition to the governance structure that relies on managing the project jointly, allowing adaptability to project needs (Raisbeck et al., 2010).

Relational Contracting Theory emphasizes the importance of putting contracts within broader relationships rather than being isolated transactions. It further emphasizes that long-term relationships can yield better project outcomes by aligning the interests of all parties and planting the seeds for long-term relationships (Macneil, 1999). IPD excelled in adhering to this principle by creating environments where continuous collaboration is maintained, risks are shared, finances are handled in transparency, and decisions are made jointly. These are features that IPD shares with other relational forms of project delivery, such as Alliancing, Partnering, and Lean project delivery systems (LPDS) (Alves & Shah, 2018). Unlike transactional contracts in traditional delivery systems, which often lead to adversarial relationships, IPD reinforces trust, minimizes disputes, and prioritizes collective success over individual gains, enhancing the chances of establishing long-term relationships (Zhang et al., 2020).

1.3.2.3 IPD in the Lens of Collaboration Theory

While Systems Theory offers a framework for understanding IPD's operational dynamics and the Relational Contracting Theory offers valuable insight into IPD contractual foundations, the collaboration theory can also be valuable in understanding the interpersonal dynamics and collaborative practices that are an integral part of IPD (Gomes & Tzortzopoulos, 2020; Hughes et al., 2012). Collaboration Theory can explain how structured collaboration leverages the collective capabilities and resources of all involved parties, enabling IPD to achieve superior project outcomes (Peng, 2015). This theory illustrates how individuals and groups work together to achieve shared goals by leveraging a set of key principles such as having common objectives., trust among the group, communicating openly, and solving problems collectively (Moradi & Klakegg, 2024; Schöttle et al., 2014; Shelbourn et al., 2007).

Collaboration theory emphasizes having shared goals that align the team's interests as a cornerstone for collaboration (Hughes et al., 2012). In IPD, this principle is operationalized both contractually and practically. IPD agreements formally bind project members who are the agents for collaboration to shared risk and reward, ensuring their financial incentives are aligned, and the trust among them starts to be established (Ahmed et al., 2021). In addition, in the start-up phase of an IPD project, a key step is the collective development of project goals, further reinforcing a shared vision of project objectives and setting the stage for effective collaboration (AIA, 2007). These measures ensure that a conducive context is created to facilitate effective collaboration (Poirier et al., 2016).

Further adhering to the collaboration theory principles, IPD structurally removes barriers between project members, ensuring open communication and the free flow of information and knowledge sharing. This is enabled through different practices, such as co-location in big rooms, which are set up to facilitate continuous engagement and collaboration among participants. In addition to adapting several artifacts such as BIM to facilitate effective communication, knowledge sharing, and data utilization, and encouraging informal and digital communication channels, further ease the communications between the team away from formal correspondences (Cheng, 2012; Rodrigues & Lindhard, 2021).

Additionally, IPD puts the principle of collective problem-solving into practice by establishing multidisciplinary teams that leverage the diverse expertise of the team early in the project. These teams contribute to the establishment of supportive structures that are deemed essential for collaboration. These teams are empowered to make their decisions and address project needs, which foster a unified approach to project challenges and enable a rich exchange of ideas that ensures collective problem-solving (Allison et al., 2018; Ashcraft, 2011).

1.3.3 The Current State of IPD Research

Building upon the transformative aspects of IPD and its foundations discussed earlier, this section delves into the dynamic landscape of IPD research, which has seen a notable increase in scholarly activity globally over the past few years despite IPD being circulated since early 2000 (Kahvandi et al., 2017). In response to the industry's call for more effective collaboration mechanisms and technological integration to tackle complex industry challenges, IPD research has expanded significantly, with scholars globally adopting diverse methodological approaches to explore its efficacy and integration challenges, particularly in collaboration with BIM and overcoming adoption barriers (Kahvandi et al., 2017; Viana et al., 2020).

Despite the extensive body of research, the landscape of IPD research and development remains notably fragmented. This domain features a disproportionate focus on certain aspects, such as exploring IPD benefits, adoption barrier, collaboration aspects, and integration with BIM, while other critical areas like decision structure, facilitation mechanisms, and team culture are less explored (Kahvandi et al., 2017; Rankohi et al., 2022; Rashed & Mutis, 2021; Viana et al., 2020). This uneven emphasis may be attributed to the absence of a comprehensive and widely recognized research development framework that organizes and integrates IPD research across theoretical and practical domains. While many frameworks exist, they tend to focus either on conceptual foundations or practical implementation, resulting in fragmented efforts and limiting the structured development of knowledge in the IPD domain (AIPMO, 2024; Ravitch & Riggan, 2016).

The absence of a cohesive research development framework highlights the existing efforts within the IPD literature, which include several frameworks developed around IPD. While these frameworks make valuable contributions, they were not specifically designed to fulfill comprehensive research and development purposes that integrate theoretical foundations with practical applications across the full spectrum of IPD. Therefore, a more unified framework could serve as a foundation to better organize research efforts, align theory with practice, and support long-term development in the field. These frameworks have been developed from two perspectives: theoretical frameworks and practically oriented frameworks, aiming to define IPD components, enhance its understanding, and frame a path for its effective implementation (Green, 2013; Kahvandi et al., 2017). For example, Aslesen et al. (2018) framed a detailed architecture, positioning IPD as a strategic delivery model that fosters collaboration among construction project stakeholders. They regarded the collaboration enabled by IPD as a catalyst to unleash the project teams' capabilities, amplify their innovation capacity, and ensure effective project implementation. Their proposed framework segments the theoretical facets of IPD into three distinct categories: contract, technology and processes, and culture, where contract and culture offer a collaborative platform, and processes and technology offer tools to enable more efficient project delivery.

Similarly, Fischer et al. (2014) introduced another model named "The Simple Framework," composed of five core elements: integrated information, integrated organization, integrated processes, and integrated building systems. This model detailed an approach for integration with a vision of executing high-performance facilities. Another important contribution was the introduction of an institutional work perspective as a mediator to understand how IPD is implemented and how it achieves enhanced outcomes. This viewpoint aids in identifying institutional elements that contribute to successful IPD or hinder its adoption (Walker & Lloyd-Walker, 2019).

On the other hand, the current landscape of IPD literature includes a broader array of practical frameworks that offer actionable insights and methodological guidance for IPD application (Heaslip et al., 2016). For instance, the Guide, AIA, 2007, considered largely as a pioneer guide in the field, is a foundational framework aimed at decoding the operational complications associated with IPD. This framework offers a detailed framework illustrating IPD components and elaborates on their implementation. Furthermore, Ashcraft (2012) described IPD through two frameworks. The Macro-Framework focuses on contract terms, business structure, and key elements like documentation, goals, stakeholder relationships, and performance metrics. The Micro-Framework addresses practical strategies to overcome project challenges, covering work processes, information management, and team organization.

Building on these contributions, industry reports by Cheng & Johnson (2016) and Poirier et al. (2022) introduced two frameworks that outline key elements of IPD. Both were reviewed by industry experts in North America, providing a detailed perspective on IPD's structure and implementation. In their thorough investigation to capture the motivations and means foundational to IPD's success, Cheng & Johnson (2016) developed a set of indicators termed "markers." These were devised using a rigorous workshop methodology, engaging participants from 10 distinct IPD projects. These markers represent the different stages of IPD processes and offer insights into the factors underpinning the success of IPD projects. Each of those markers was categorized under one of six categories: Context, Legal/Commercial, Leadership/Management, Processes/Lean, Alignment/Goals, and Building Outcomes. Building on Cheng & Johnson's foundational work, Poirier et al. (2022) restructured these markers to attain a more systematic flow, reflecting their investigation of IPD's success factors in the Canadian construction industry. Their categorization aimed to align more seamlessly with the IPD processes, emphasizing the pivotal components supporting IPD's effective implementation and categorizing them into Making the Case for IPD, Framing the Project, Choosing the Team, Setting the Context, Executing the Work, Maintaining Excellence, and Reaping the Benefits.

As evidenced above, the current IPD domain heavily leans towards practical frameworks. This inclination can be understood given IPD's industry-driven nature and the consequent research endeavors that are striving to keep pace. However, such imbalance underscores that while the practical frameworks excel in the application, they often lack a structured approach to integrating these practices with broader theoretical underpinnings that could influence the field and inform long-term strategic developments and innovations, especially since they focus on operational efficiency, addressing specific project challenges, and optimizing direct outcomes

(Nilsen, 2015). Similarly, the limited theoretical frameworks available, while detailed in describing foundational IPD components, often remain disconnected from practical implementation concerns, reinforcing the need for a framework that bridges theory and application (Green, 2013).

Recognizing these shortcomings regarding the imbalance and disjointed research domain highlights an important gap detailed in the following subsection.

1.3.3.1 Gap in Knowledge: Scattered Research and Development Domain

Given the fragmented landscape of IPD research, various scholars and practitioners have developed frameworks aimed at consolidating IPD's complex components. Typically, these frameworks tend to either concentrate on theoretical underpinnings or on practical implementations, underscoring the lack of a cohesive research and development framework. Yet, the diversity of these frameworks revealed a lack of a holistic approach, as they are not specifically designed to address the comprehensive needs of IPD research and practice in a unified manner.

The absence of a commonly accepted IPD R&D framework for IPD leads to a landscape where its full potential is not well leveraged, and useful findings remain fragmented across disparate areas of study or practice. A structured framework that incorporates both theoretical and practical perspectives into a coherent and overarching framework would be beneficial in consolidating the research efforts, framing a clear path for continuous development, and enhancing the understanding of the multifaceted aspects of IPD. Incorporating an R&D approach also has the effect of illuminating areas that require further exploration. By identifying these research opportunities, the research efforts can be channeled more effectively, addressing challenges that have yet to be fully understood, optimizing this innovative approach, and enhancing the overall potential of IPD.

1.3.4 The Current State of IPD Implementation and Adoption

IPD, indeed, has gained significant traction as an alternative to traditional project delivery methods that offer a more collaborative and efficient approach to construction projects, evidenced by a growing trend in adoption within the construction industry, similar to the growing trend in research illustrated in the previous section (AMR, 2025; IPDA, 2023; Weinmann et al., 2024). The IPD market is projected to reach $7.947 billion by 2033 with a compound annual growth rate (CAGR) of 14.4% (AMR, 2025). However, its widespread adoption remains limited and never approaches the share market of traditional delivery methods. The 2020 AIA Firm Survey Report found that IPD-related services accounted for only 3% of firm revenue (AIA, 2020). In Canada, figures from the Integrated Project Delivery Alliance show that in 2023, 106 documented projects were delivered using IPD (IPDA, 2023). While this expansion can be articulated as an increasing recognition of IPD's potential to enhance project outcomes, it still represents a very small percentage of the industry operation.

While the reasons for this reality can vary, it stresses the fact that IPD remains a novel and evolving practice, facing various institutional, regulatory, and industry barriers, and should overcome various challenges regarding its implementation, standardization, and validity before seeing higher levels of adoption (Bhonde et al., 2020; Buk’hail & Al-Sabah, 2022; Ghassemi & Becerik-Gerber, 2011; Kumar, 2022; Li & Ma, 2017; Ma et al., 2022).

Among the most prevailing barriers comes the construction industry's inherent conservatism approach that continue to rely on traditional, less collaborative project delivery methods, which hinders the integration of innovative models like IPD. These traditional methods are deeply rooted within the sector's operational norms and are braced by established regulatory frameworks which do not always accommodate the collaborative essence of IPD (Bhonde et al., 2020; Ma et al., 2022).

IPD's growth, while promising, highlights a disparity in its adoption across different sectors. For instance, its uptake is more pronounced in sectors where the benefits of collaboration and integration are immediately apparent, such as large-scale commercial, industrial, and healthcare projects. These projects often involve multiple stakeholders whose effective collaboration can directly influence project success (Hanna et al., 2023; Wellman, 2020). In contrast, smaller projects or those in less regulated environments may not see the same level of IPD adoption, primarily due to the perceived overheads associated with setting up collaborative agreements and aligning multiple parties' interests (Ghassemi & Becerik-Gerber, 2011; Ma et al., 2023).

The educational aspects and the lack of knowledge also play a critical role in IPD's limited market share (Bhonde et al., 2020; Buk'hail & Al-Sabah, 2022). There is only a limited number of educational initiatives to inform industry professionals about the benefits and mechanics of IPD. Notable examples include the Integrated Project Delivery Alliance (IPDA) in North America and Canada in particular, the Lean Construction Institute (LCI), and the American Institute of Architects (AIA), which have developed resources, training programs, and guidelines to support IPD adoption. However, there is a need to expand these educational efforts to include a broader range of industry participants to facilitate a deeper understanding and awareness of IPD, potentially accelerating its adoption and overcoming the lack of knowledge barrier identified by many studies (Bhonde et al., 2020; Kumar, 2022; Li & Ma, 2017; Ma et al., 2022).

Additionally, as a novel approach, the full potential of IPD remains constrained by the need for more refined frameworks, mechanisms, and tools to optimize its application and ensure a wider adoption across the industry. Among the pressing matters, there is still a lack of distinct tools and frameworks that could allow an informed assessment of IPD practices necessary to facilitate continuous improvement and enhance its implementation (Rashidian et al., 2022).

As evidenced above, while the horizon for IPD is promising and its growing adoption is likely to continue, significant gaps remain that must be addressed to fully realize its potential. The current state highlights both the opportunities and the challenges inherent in this evolving approach. To optimize implementation and accelerate adoption, efforts should actively address its adoption barriers, implementation challenges, and any structural shortcomings. Therefore, the following subsection will focus on the gap this study aims to bridge, specifically around the absence of structured tools to evaluate and enhance IPD practices and implementation.

1.3.4.1 Gap in Practice: Absence of Structured Tools to Evaluate and Enhance IPD Practices

As IPD continues to evolve as a collaborative project delivery method, its growing application has revealed important gaps in both practice and theory, particularly concerning how implementation is assessed, guided, and improved. While existing frameworks describe IPD principles and project-level applications, there remains a lack of structured tools that formalize and operationalize key IPD concepts such as readiness and maturity. This limits the ability to evaluate implementation effectiveness, compare performance across projects, or support continuous improvement in a systematic way.

The absence of such tools presents not only a practical gap but also a conceptual gap in understanding and studying IPD implementation. Without tools that allow structured evaluation, key capabilities remain difficult to assess empirically. This hinders the formalization of knowledge around how IPD works in practice, how it evolves over time, and under what conditions it succeeds.

Addressing this gap requires the development of structured tools that can assess project readiness and evaluate the maturity of IPD implementation. Such tools would support both industry applications and academic investigations by enabling systematic and repeatable evaluations across different contexts, thereby formalizing key dimensions of IPD performance. This can contribute to both improving practice and advancing theoretical understanding.

1.4 Problem Statement

Designed to enhance project outcomes through elevated collaboration and integration among stakeholders, IPD represents a transformative approach to construction management. The current state of this approach shows that it has moved beyond the initial steps of adoption and proven feasibility, evidenced by global application and a vast number of documented case studies. It is now facing the inevitable next stage of optimizing its practices, addressing remaining gaps in its structure and tools, and achieving widespread adoption. Therefore, the theoretical underpinning and practical applications of IPD should be the target of forthcoming investigations and developments to address any existing deficiencies. These deficiencies are particularly pronounced in the underdeveloped and disjointed research and development domain and the lack of structured assessment tools that evaluate and guide IPD implementations from inception through to post-completion.

The research landscape of IPD is notably scattered, with the absence of a widely recognized research and development framework, leading to isolated insights that inadequately address the complexities involved in implementing such integrative project delivery methods. The existing frameworks show an unbalanced focus that heavily leans towards a practical framework, reflecting the fact that IPD is driven by the industry while the academy strives to keep up. Additionally, these frameworks do not address the comprehensive needs of both the IPD research and practice in a unified manner. This disconnection between theory and practice creates a substantial gap, hindering the potential benefits of IPD from being fully realized and integrated into construction practices. A structured research and development framework that incorporates both theoretical and practical perspectives into a coherent and overarching framework would be beneficial in consolidating the research efforts, framing a clear path for continuous development, and enhancing the understanding of IPD constructs.

Moreover, IPD, as a relatively new and evolving approach, is still progressing toward optimizing its practices and achieving wider industrial diffusion. An important pressing step on this path is addressing the lack of distinct tools and frameworks that could allow an informed assessment of IPD capabilities, maturity, and readiness necessary to facilitate continuous improvement of IPD practices. In particular, a maturity model and tool for IPD can enable an informed evaluation of IPD practices at project completion and facilitate continuous improvement, while a readiness model and tool can enable an informed assessment of a project's readiness to start implementing IPD. This, in turn, allows projects to align their efforts and resources for more effective implementation. This absence of structure maturity and readiness models leaves industry practitioners without essential tools to effectively assess the readiness to start implementing IPD and measure the maturity of IPD practices implementation at the end of the project. Both are essential to facilitate a path for more standardized and consistent IPD implementation.

Therefore, the central issues this dissertation addresses are, firstly, the critical need for a coherent and comprehensive research and development framework that bridges the theoretical constructs of IPD with its practical applications and organizes the IPD research and development domain. Secondly, enhancing IPD practical application by providing empirical tools to assess readiness for IPD implementation at the project initiation and evaluating the maturity of IPD practices at the project completion. Addressing these issues is pivotal for advancing the theoretical understanding and the practical application of IPD and, therefore, facilitating continuous improvement, fostering more consistent and standardized IPD practices, and enhancing its overall efficacy. Ultimately promoting IPD's widespread adoption within the construction sector.

1.5 Research Question and Objectives

Based on the problem statement presented above, the central research questions that guided this dissertation are: **What are the key characteristics of Integrated Project Delivery (IPD)? How can these characteristics be articulated to organize the research and development domain? How can this articulation enable informed evaluation, consistent implementation, and continuous improvement of IPD?**

This inquiry seeks to identify the foundational elements that underpin IPD and create a framework that links theoretical constructs with practical applications to enable a clear path for research and development on IPD. In addition, it aims to enhance the implementation of IPD by developing models and tools that enable informed evaluation and continuous improvement of IPD practices both at the project initiation and completion phases.

The exploration of this research question is poised to contribute to the field of project delivery systems in general and IPD in particular. It aims to establish a theoretical framework that consolidates dispersed research findings into a structured knowledge frame and organizes the IPD research and development domain, enhancing IPD understanding and fostering innovative developments. Therefore, answering the first part of the research question regarding the key characteristics of IPD and how they can articulate it to organize the research and development domain.

In addition, this study aims to develop an IPD Maturity Model and a maturity assessment tool to enable an informed evaluation of IPD practices at the project level. This model enables organizations to benchmark their practices against industry standards, identify areas for improvement, and monitor progress over time. Complementing this, the study aims to develop an IPD Readiness Model and readiness assessment tool to enable an informed evaluation of projects' readiness to start implementing IPD by ensuring that all necessary conditions and resources are aligned before project commencement. Formulating an IPD Readiness Model will expand the theoretical base for project initiation by integrating readiness assessment into the IPD context. By establishing maturity and readiness tools that assess and guide IPD practices, this research aims to promote a more standardized and consistent approach to IPD implementation and enable continuous improvement, thus driving the broader adoption and success of IPD across the construction industry. Therefore, answering the second part of the research question regarding enabling an informed evaluation, consistent implementation, and continuous improvement of IPD practices.

1.6 Research Approach

Having identified the research question and main objectives, this section outlines the research approach adopted. It details the steps taken to develop the artifacts in this study, guided by the principles of design science research (DSR) and underpinned by a pragmatic philosophical stance.

1.6.1 Philosophical Foundation: Pragmatism

This study approach is deeply linked to pragmatism as the guiding philosophy. Pragmatism is a philosophical approach that is primarily oriented to the practical application of ideas and solutions. It derives from the philosophy that knowledge always originates from experience and that the true value of ideas is through their application (Kaushik & Walsh, 2019). Embracing a perspective where practical outcomes are prioritized, the development steps of this research reflect a pragmatic approach where the resulting frameworks, models, and tools resonate with the dynamic and practical realities of IPD. This philosophy also aligns with the Design Science Research (DSR) approach, the methodological framework applied in this study as detailed in the following subsection, where both focus on outcomes and impacts rather than only theoretical abstraction. Pragmatism in this study underlines the use of theories and frameworks in real settings, which have the key focus on how well they can address real-world challenges (Barton, 1999).

Furthermore, pragmatism argues that researchers must be flexible, adaptive, and problem-solving-oriented, which is reflected in the objective-driven methodology followed in the three research steps to come up with effective solutions within the complex domain of IPD. This approach, thus, encourages combining different methods, designs, and approaches in the same study to best address the problem statement (Becker et al., 2009). In taking this pragmatic position, this research seeks to theoretically contribute while ensuring that the results are practically relevant and applicable directly in the field, furthering both the understanding and the implementation of the IPD approach.

1.6.2 Methodological Framework: Design Science Research

The overarching methodological approach employed in this study is design science research (DSR), which is characterized by the intent to develop and test artifacts to solve complex problems. DSR is more prevalent in disciplines such as engineering and information systems studies, where functional and practical solutions are needed. In this research methodology, the development of novel, purposeful constructs, models, frameworks, methods, or tools is emphasized, and their utility is gauged in real life studies (vom Brocke & Maedche, 2019).

The core concept in doing design science research lays in the idea that knowledge is built and, at the same time, conceived through the invention and application of novel artifacts. Therefore, this methodology exceeds the aim of understanding a phenomenon to attempt to change it by introducing novelty and innovation. DSR normally follows the cycle of identification of a problem, creating an artifact to solve that, and iterative testing and refinement to ensure effectiveness and utility. The iterative nature draws out the essential features of design science: dynamic, adaptive, and open to ongoing improvements or adaptations of the artifact based on feedback and changing requirements. This approach manifested through a staged process of understanding the issues, leveraging existing knowledge, and then developing and refining the tool through application and validation, as shown in Figure 1.1 (Venable et al., 2012; vom Brocke et al., 2020).

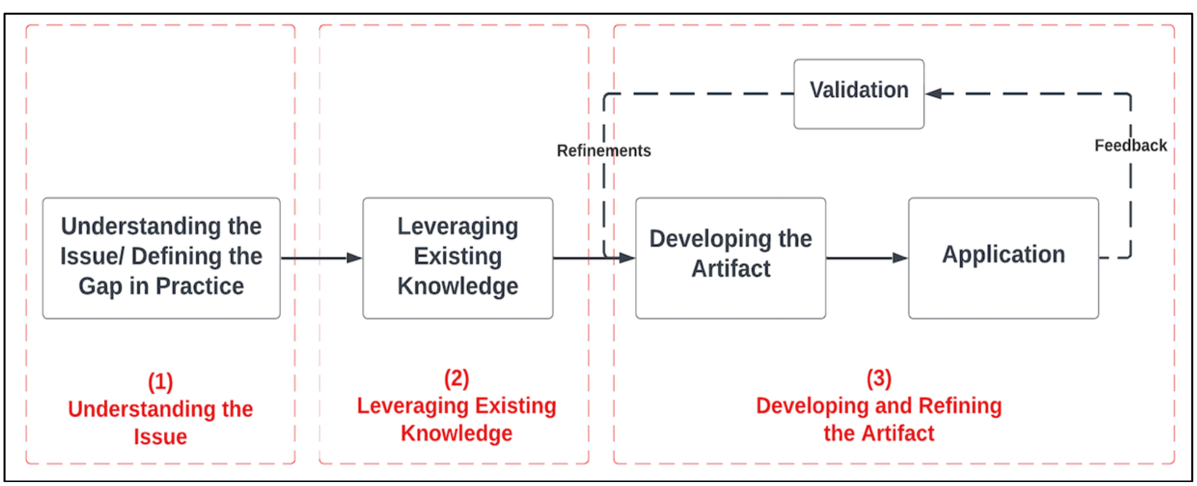

Figure 1.1 Design Science Research (DSR) Steps

1.7 Research Methodology

In accordance with the pragmatism and the Design Science Research (DSR) framework, the research conducted in this study is organized into three steps, as illustrated in
Figure 1.2. The first step involved developing an IPD Research and Development Framework, which focuses on identifying gaps and understanding foundational issues, representing the first step of the DSR process: understanding the domain/issue. It involves understanding the field and establishing a structured path forward for development. It sets the foundation for subsequent steps by capturing the state of knowledge and introducing the R&D framework that articulates the critical gaps and challenges within IPD. The second step concerns leveraging existing knowledge, in which the capability framework was established through the integration of existing IPD frameworks and empirical insights from IPD case studies. The third and fourth steps comprise two parallel lines of development: the Capability Maturity Model and the Capability Readiness Model. Each model adheres to the DSR cycle concerning developing and

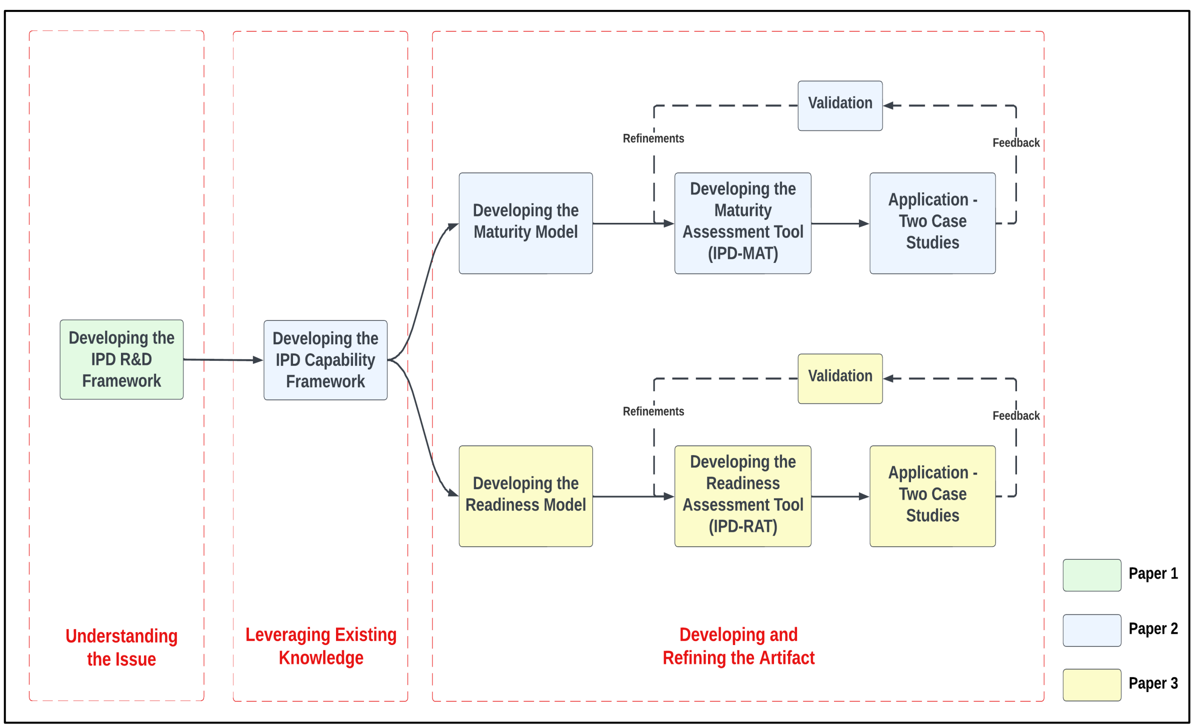

Figure 1.2 Research Flow Chart - DSR Inspired

refining tools. Together, these models address distinct phases of IPD implementation, providing complementary tools for assessing pre-project readiness and conducting post-project evaluations. The methodology employed varies among those three steps, including a variety of methodological procedures and data collection and analysis techniques, as detailed in the following subsections.

1.7.1 Data Collection

Throughout this research, the empirical approach played a crucial role in developing and validating the findings, ensuring the robustness of the contributions made, and enriching the academic literature with practical insights. This research involved extensive empirical data collection, including five IPD case studies in four Canadian provinces. More than 50 professionals from the industry were interviewed throughout the study period, engaging participants from more than 30 firms with more than 50 hours of interviewing, in addition to three surveys and access to over 100 project documents. This rich dataset offers substantial empirical support and strengthens the proposed models, frameworks, and tools. This approach ensures that the contributions are theoretically informed and empirically validated, enhancing their relevance and utility in advancing IPD practices within the construction industry.

In the details, A mixed-method approach was employed as a data collection strategy in this study. This approach combines the depth of qualitative data with the breadth of quantitative data, providing a comprehensive understanding of the research topic (Creswell & Clark, 2017; Doyle et al., 2009; McKim, 2017). This study collected quantitative and qualitative data from five case studies in four Canadian provinces, providing nuanced insights into the IPD framework and practices across various contexts, which were crucial in developing the study findings. The collected data included in-depth interviews, surveys, project documents, evaluation sessions, and follow-up interviews. This richness and diversity in data collection allowed for in-depth exploration and was particularly beneficial in allowing data triangulation and strengthening the validity of the research findings by confirming evidence from multiple sources (Carter et al., 2014; Heale & Forbes, 2013).

While the research unfolded in three distinct yet interconnected parts that contributed complementary perspectives to understanding and enhancing IPD implementation, the data collection spanned different phases throughout the study duration. Some of the data collected contributed directly to this study's main contributions presented in articles 01, 02, and 03 (refer Chapters 2, 3, and 4), while other data collection was part of investigations that represent secondary contributions of this study and referred to as secondary data, as illustrated in **Figure 1.3**. Both, primary and secondary data, contributed to a more profound understanding of IPD, its challenges, implications, and ways to optimize its practices.

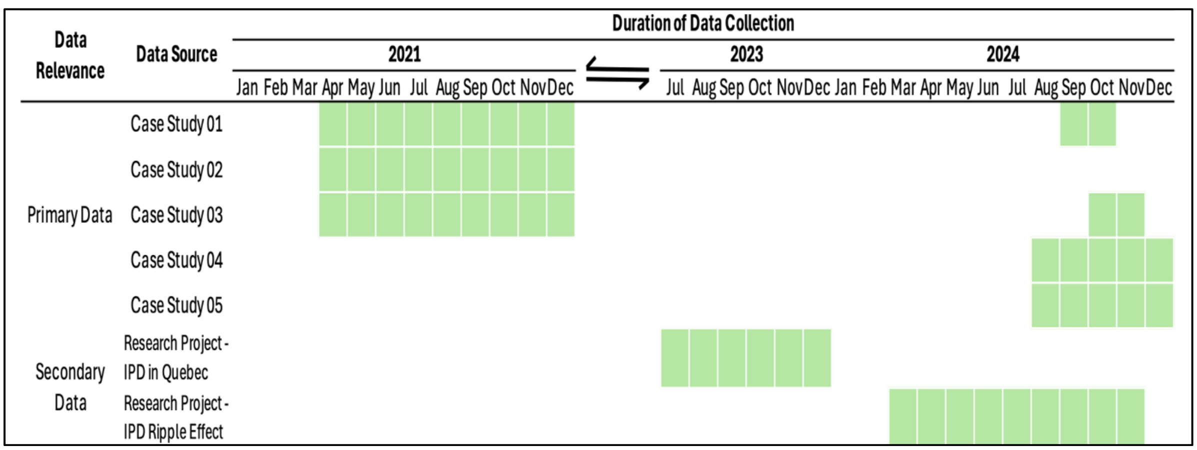

Figure 1.3 Data Collection Timeline

1.7.1.1 Interviews

In-depth interviews were conducted with industry professionals and experts from five different case studies and a research project. The interviewees' sample included representatives from all the project's stakeholders, including owners, general contractors, architects, engineering firms, sub-trades, and facilitators. These interviews provided comprehensive and deep insights into IPD's multifaceted aspects. In general, a total of 41 interviews were conducted with a total of 57 interviewees who represent 40 different organizations. These interviews account for 51 hours of interviewing, as illustrated in **Table 1.1**.

The first three case studies were used as a part of the development process of Articles 01 and 02, presented in chapter 2 and chapter 3, particularly in developing the IPD R&D framework and the IPD capability framework that was used to develop the maturity model. Later, two cases among these three were revisited with evaluation sessions and follow-up interviews to validate the maturity assessment tool. In addition, the last two case studies were engaged as part of the validation process of Article 03, presented in **chapter 4**, to validate the readiness assessment tool.

Table 1.1 Number of interviewees per discipline and per case study

Data Source	Data Relevance	Data Utilization	Number of Interviewees per Discipline					
			Owner	Architect	Engineering Firm	General Contractor	Specialty Contractor	Facilitator
Case Study 01	**Primary Data**	**Chapter 2** **Chapter 3**	2	2	4	1	3	1
Case Study 02			2	2	2	1	2	0
Case Study 03			2	3	8	4	3	1
Case Study 04		**Chapter 4**	3	0	0	0	0	0
Case Study 05			4	0	0	0	0	0
Ripple Effect	**Secondary Data**	**ANNEX IV**	1	1	1	2	1	1

Moreover, another set of interviews was conducted to investigate the influence of IPD on organizational practices. A secondary contribution of this dissertation, presented in Chapter -1168449024 III. These interviews were instrumental in understanding the border impact of IPD on organizational practices and how IPD could initiate a systematic change within the construction industry toward a more collaborative work environment and trust-based and transparent culture.

The five case studies represent a diversity in project type, location, and conditions. The following is a brief description of each of them:

- **Case Study 01: Canada Games Aquatic Center**

This case study is a renovation and development project for the Canada Game Aquatic Center in Kamloops, BC. It was the first IPD project in British Columbia. The project involved renovating and upgrading the City's main indoor pool, which was originally constructed in 1992 for the 1993 Canada Summer Games. Over the years, the existing building envelope, as well as the mechanical and electrical systems, showed signs of fatigue and were nearing or beyond the end of their expected service life. Therefore, the project's main objectives were to upgrade the facility, increase overall building durability with an innovative envelope and mechanical solutions, reduce energy use, and reduce greenhouse gas (GHG) emissions. The project utilized the Hanson Bridgett IPD contract and involved 10 signatories to the agreement.

The engagement of this case study was made in two stages. The first stage included interviewing all IPD project members, conducting a survey, and analyzing the project documents. This was part of a project aiming to investigate the factors leading to IPD success in the Canadian construction industry. The second stage was during the validation of the maturity assessment tool, where an evaluation session of the IPD practice's maturity was conducted in cooperation with the project owner. Then, a follow-up interview was held to discuss the evaluation findings and obtain feedback on the tool's utility and relevance.

- **Case Study 02: Thelma Chalifoux And Soraya Hafez Schools**

This case study involved the construction of two public schools within the Edmonton Public School Board: Thelma Chalifoux School and Soraya Hafez School (TCSH). These schools were required to be aligned with 21st-century learning and design principles. A relatively new concept in designing educational facilities necessitated the team to have a high level of collaboration and flexibility to fulfill this requirement.

These two schools were grouped into a single IPD project and team, even though they were separate IPD contracts. The project utilized the Hanson Bridgett IPD contract and involved 13 signatories to the agreement. The engagement with this case study included interviewing representatives from all IPD project members, administering a survey to project participants, and analyzing the project documents. Similar to case 01, this case was also part of a research project investigating the factors leading to IPD success in the Canadian construction industry.

- **Case Study 03: Barrie-Simcoe Emergency Services Campus**

The Barrie-Simcoe Emergency Services Campus was a collaborative effort between the City of Barrie, the principal owner, and the County of Simcoe, the co-owner. The project concept was to bring together the Barrie Police Service, the Barrie Fire and Emergency Services, and Simcoe County Paramedic Services on a shared campus in a mutually beneficial collaboration structure. As such, each partner would have access to more efficient and enhanced facilities via shared spaces and staff amenities than what would be practicable or economical in separate standalone buildings. The modern facilities created in this project were intended to improve efficiency among first responders while achieving savings both upfront and during operations.

The project utilized the Hanson Bridgett IPD contract and involved 17 signatories to the agreement. Similar to case 01, the engagement of this case study was made in two stages. The first stage included interviewing all IPD project members, conducting a survey, and analyzing the project documents as part of a research project that investigated the factors leading to IPD success in the Canadian construction industry. In addition, a second stage of engagement with this case study was made during the validation of the maturity assessment tool where a comprehensive evaluation of the project IPD practices maturity was conducted, and then a follow-up interview was held with the project owner to get their feedback on the bra and the tool in the tool relevance and utility.

- **Case Study 04: DOW Complex Project - ETS**

This case study was part of the validation process of the Readiness Assessment Tool, presented in Article 3, Chapter 4. The DOW Complex Project involves a complete rehabilitation of the former DOW Brewery site in Montreal. The space will be mainly academic and research laboratories, as well as parking. The case study involved evaluating the DOW Complex Project's readiness to implement IPD. The project is still in the early stages and will be implemented using IPD as a delivery system. A comprehensive assessment of the project's readiness to implement IPD was conducted with the project owner. This step was followed by preparing a readiness assessment report based on the evaluation findings. Then, a follow-up interview with three representatives from the project was held, where the report findings were presented, and the tool's utility and applicability were discussed.

- **Case Study 05: SQI synthetic project**

This case study was based on a synthetic project for the Société Québécoise des Infrastructures (SQI). SQI is a governmental organization in Quebec, Canada, that manages public infrastructure projects. They are looking to expand collaborative practices and are actively considering adopting IPD within their projects.

Similar to the steps in case study 04, a comprehensive evaluation of readiness to implement IPD by assessing the SQI synthetic project, replacing a mechanical system in a downtown office tower in Montreal, was performed. This step was followed by preparing a readiness assessment report and conducting two interviews with four SQI members to gather feedback and discuss the assessment tool.

1.7.1.2 Surveys

While the surveys conducted in this study were not part of the primary data collection that directly contributed to the main three parts of this research presented in articles 1, 2, and 3, they played a significant role in enhancing the understanding of different aspects of IPD, mainly by providing a quantifiable perspective to the study and allowing triangulation of data. These surveys directly contributed to developing several secondary contributions made throughout this study. In particular, the technical report titled "Investigated Factors Leading to IPD Project Success within the Canadian Construction Industry," the conference paper titled “IPD in Quebec: Exploring Awareness, Perceptions, and Challenges” (refer to ANNEX II), the conference paper titled “Exploring Integrated Project Delivery Through the Lens of Innovation Diffusion Theory: Its Role in Evolving Organizational Practices” (refer to ANNEX III) and lastly the technical report titled “Ripple Effect: The Role of IPD in Evolving Organizational Practices."

The first survey was administered to the participants of the first three case studies. The results were used to supplement the detailed interview and document analysis in those three cases as part of a research project that investigated the factors leading to IPD's success in the Canadian construction industry. A total of 36 responses were received that represent the diversity of the stakeholder landscape, including the owner, architect, engineer firms, general contractor, and specialty contractor.

The second survey investigated the awareness, perceptions, and challenges of IPD within Quebec. A total of 86 responses were considered complete and valid for analysis. This set of responses represents a broad range of Quebec construction industry practitioners, providing a rich overview of current knowledge and awareness about IPD in Quebec. It enabled a clearer understanding of how the industry perceives this approach and the barriers and challenges that prevent its adoption.

The third survey was administered as part of an investigation into the influence of IPD on organizational practices. A total of 55 responses were received to this survey. Among them, 24 responses were valid for analysis. Those responses came from Canadian professionals who experienced and implemented at least one IPD project, making the data collected valuable in understanding the border impact of IPD within the construction industry. This survey helped provide a quantifiable weight to the influence of IPD on the different organizational practices. It was also used in triangulation with the interviews to conclude how experiencing IPD at the project level could initiate a systematic change toward collaboration and a trust-based culture within the construction industry.

1.7.2 Data Analysis

Throughout this study, various methodologies and techniques for data analysis were employed, primarily driven by the study's objectives and the most suitable approach to answering the research question. In the first step (**refer chapter 2**), the data analysis involved a systematic combining process, allowing for a dynamic interplay between theory and empirical data. Systematic combining ensures a continuous adjustment of the theoretical framework as new data and insights emerge without constraining the scope of discovery by sticking rigidly to initial hypotheses; this kind of adaptability is particularly relevant in the context of IPD, where a limited number of frameworks are available to guide the development process (Dubois & Gadde, 2014). Therefore, the systematic combining process represents an integrated approach that serves as a dynamic method to synthesize diverse perspectives and data sources into a coherent and comprehensive R&D framework that effectively represents the IPD landscape. This process facilitates the merging and leveraging of existing IPD frameworks with practical inputs from IPD case studies and expert evaluations to develop the IPD R&D Framework, which was complemented by a systematic literature review to map out the IPD research and development domain comprehensively.

In the second step (**refer chapter 3**), the DSR steps were followed to develop the IPD Capability Maturity Model and its associated maturity assessment tool. This work builds on the knowledge established in the first step, introducing a structured capability maturity model. The process combined insights from existing IPD frameworks, maturity models, and three IPD case studies. The methodology employed for developing the IPD maturity model was guided by the procedural frameworks of Becker et al. (2009) and De Bruin et al. (2005), which outline comprehensive procedures for maturity model development. These methodological procedures emphasize the need to clearly define the problem domain, objectives, and target audience in the first step. Then, review the existing maturity models to inform the development strategy and outline the model's structure in the next step. Next, an iterative development process that incorporates stakeholder feedback and refining the model through cycles of testing and validation should be applied. Finally, implementing the model within the intended context and providing guidelines for its use.

To analyze the data of the three case studies, the research initially performed a cross-framework analysis using a number of established IPD frameworks to create a capability framework for IPD. The IPD capability framework acted as a coding framework and guided the thematic analysis conducted on the data of the three case studies to identify the capability indicators and their maturity levels extracted directly from practical implementations of IPD. Thematic analysis, as employed here, involves systematically organizing and interpreting the case studies dataset to uncover patterns and themes, which is an effective analysis technique for detailed, qualitative insight, particularly in new subject areas (Braun & Clarke, 2006; Clarke & Braun, 2017). Therefore, the coding process traced the observable behaviors, norms, policies, activities, tools, and practices that represent the indicators of IPD capabilities and their different maturity levels of implementation and coded them against the IPD capability framework. This approach validates the capability framework and also ensures that the maturity model reflects real-world complexities and interactions. Therefore, in a staged development, the maturity model and tool for IPD were created and then validated through evaluation sessions and feedback interviews with key stakeholders of two cases of the three IPD case studies originally used to develop the model.

In the third step (**refer to chapter 4**), the same foundational knowledge is leveraged to develop the IPD Capability Readiness Model and its readiness assessment tool, following the same DSR steps: leveraging the existing knowledge, developing the tool, and refining it through case studies. In this step, the IPD capability framework established in the previous step was leveraged and extended through a framework synthesis process to develop the IPD capability readiness framework. Framework synthesis is a qualitative synthesis method used to integrate existing theories or frameworks with empirical data to understand complex phenomena comprehensively. It involves identifying a relevant conceptual framework to guide the synthesis, then systematically integrating empirical data, and mapping this information onto the predefined framework (Brunton et al., 2020; Schick-Makaroff et al., 2016). While it is usually used to synthesize frameworks in a review process, this study employed the concept of framework synthesis to integrate and synthesize IPD capabilities, readiness indicators, and readiness checkpoints into a detailed readiness matrix (Brunton et al., 2020).

This development was succeeded by a validation stage, in which the tool was utilized in two case studies. The application entailed evaluating the readiness of the cases to implement IPD, followed by follow-up interviews and feedback sessions with key representatives from both cases.

1.7.3 Validation

Establishing validity is a vital step in research aiming to confirm the accuracy and applicability of both the research approach and findings (Anderson-Cook, 2005). It ensures that the study reflects real-world phenomena and challenges it intends to represent and address. Applying a rigorous validation strategy can strengthen the credibility of the research results and enhance their contribution to knowledge and practice (Creswell & Miller, 2000)..

This study involved an in-depth exploration of IPD's theoretical underpinnings and practical applications, aiming to enhance its implementation and efficiency. Matching this aim, the overarching approach to validation in this study hinges on a comprehensive strategy that integrates data from case studies, expert interviews, systematic literature reviews, evaluation sessions, and feedback loops. This approach exemplifies the triangulation and ensures a multi-faceted examination of the IPD framework (Carter et al., 2014). Anchoring the research in real-world applications and practitioners feedback was crucial to developing practical and relevant tools that can enhance IPD implementation. Each step in this thesis, represented in articles 1, 2, and 3, employs distinct validation techniques appropriate to its objectives. In particular, the approaches used concern objectivity, confirmability, reliability, dependability, audibility, and internal and external validity, which guide the assessment of the robustness and applicability of the research approach and outcomes.

In terms of objectivity, it ensures the findings are free from the researcher's biases and emphasizes presenting a perspective that stands independent of personal feelings or predispositions (Creswell & Miller, 2000). In addition, reinforcing the research's credibility can be achieved through the concept of confirmability, which concerns the results' consistency. This can be accomplished by ensuring a clear and transparent methodology that can be replicated and independently verified by others (Johnson, 2007). Further, reliability focuses on the consistency of measurement across time and across various observers, where the methodology should yield the same results on repeated trials. This will stabilize the research outcomes across varied contexts and applications (Denzin, 2017). Dependability, on the other hand, emphasizes the need for the research process to be traceable and consistent over time, particularly in qualitative research where conditions can be more fluid and variable. It stresses maintaining reliable and logical processes and results despite any changes in research conditions (Athens, 2010). Complementing this concept, audibility involves creating detailed documentation of all aspects of the research steps, allowing the research to be audited (Gibbs, 2018).

Finally, internal validity is an essential concept for establishing validity, as it ensures that the study accurately reflects the phenomenon being examined and is free from confounding variables. This, in turn, confirms that the results stem directly from the variables tested rather than from external influences (Shenton, 2004). External validity, on the other hand, broadens the applicability of the findings beyond the immediate study context, facilitating the generalization of the results to other settings. This is crucial for the practical application of the research findings in real-world settings (Thomas & Myers, 2015).

- Research and Development Framework for IPD (refer to **chapter 2**)

The research and development framework was validated in two stages: validating the research approach and validating the research findings. The approach was validated through collaboration with expert librarians, who reviewed the systematic literature review process and provided their recommendations before its commencement. Additionally, an external validator independently followed the same process and applied it to 15% of the selected papers to ensure the review process yielded the same outcomes despite the researcher performing it. Furthermore, the results were verified using empirical data from three IPD case studies and evaluated by a panel of experts with extensive knowledge of IPD frameworks.

Confirmability: Two specialized librarians from the École de Technologies Supérieures evaluated the review protocol and research process to ensure its integrity and compliance with academic standards. Subsequent adjustments enhanced the study protocol, emphasizing the confirmability of the research by making sure that the methodologies used were transparent and could be independently verified.

Reliability: An external validator was engaged to ensure the reliability of the process. This was accomplished by having the validator randomly select 15% of the papers used in this study, then extracting necessary data and classifying them to verify the consistency of the researcher's coding process. Achieving a 98% match after a detailed discussion of discrepancies highlights the reliability of the data coding and classification methodologies.

Dependability: The systematic literature review was thoroughly documented. This includes detailing every step taken and transparently justifying all the decisions made during the research. This explicitly ensures that the process is dependable and can be replicated by other researchers, reinforcing the transparency and rigor of the study.

Audibility: The framework was further validated and refined through feedback from a panel of IPD experts. The research and performance community of the Integrated Project Delivery Alliance (IPDA) served as a validating unit for this study. Through frequent meetings during the study period, the progress and the outcomes were presented to them, and their feedback was continuously incorporated, further validating the research outcomes.

External Validity: An essential part of the validation for the research and development framework was the use of empirical data from three IPD case studies in different Canadian provinces. These cases provided a diverse range of data and contexts, showcasing the framework's applicability across various geographic and operational settings within the Canadian construction industry and underscoring its external validity.

- Capability Maturity Model for IPD (refer to **chapter 3**)

The validation of the Capability Maturity Model was established through a series of interactive sessions tailored specifically to ensure the model's relevance and effectiveness in actual project environments. Therefore, the process was designed to validate the finding by returning to the three case studies that served as the basis for development.

Confirmability: The process involved structured feedback interviews with key stakeholders, particularly the representatives of the owners, who provided detailed and valuable insights into the effectiveness and accuracy of the maturity model and its assessment tool. These interviews ensured the findings were consistent with stakeholder experiences and expectations, confirming the research outcomes.

Reliability: The maturity assessment tool, which featured a structured questionnaire, was administered during the evaluation sessions with the project's stakeholders to ensure reliability. This structured approach ensured the tool consistently determined the maturity levels across the projects examined in this study and avoided any bias by the researcher.

External Validity: By returning to the three case studies initially used to develop the model, the study ensured a broad applicability of the findings. The diversity of these projects in terms of geographical location and project types confirmed the tool's effectiveness across various settings in the Canadian construction industry and demonstrated its external validity.

- Capability Readiness Model for IPD (refer to **chapter 4**)

The capability readiness model was validated in alignment with DSR principles. The study adopts a naturalistic, ex-post-validation approach, employing real-world IPD case studies to assess the developed readiness tool. Two public bodies organizations in the very early stages of implementing IPD were engaged. The tool was applied to these projects, where evaluation sessions took place, followed by preparing a detailed readiness assessment report for each case. Then, follow-up interview/s with key representatives were conducted to gather feedback and discuss the tool's relevance and applicability.

Confirmability: The feedback sessions with key representatives from the two projects where the readiness tool was applied serve as a crucial element for confirmability. These sessions ensured that the model and its associated tools accurately reflect the readiness assessment needs of IPD projects. The stakeholders' input on the tool's relevance and utility confirmed that the model measures the intended readiness aspects effectively.

Reliability: The readiness tool was consistently applied across different projects to evaluate IPD readiness. This consistent application and the structured approach to gathering feedback underscore the reliability of the research approach, ensuring consistency across various project settings.

External Validity: By applying the readiness model to two different projects, the study tested the model's applicability in different project environments. However, the limited number of case studies implies limitations about the model's generalizability in various types of IPD projects, which is a point that can be enhanced by extending the application of the tool to more case studies that represent diversity in project type and geographic location.

1.8 Dissertation Structure and Contributions

The research unfolded in three interconnected parts, associated with three articles presented in this dissertation. These parts collectively illustrate a holistic approach to IPD, spanning from establishing a thorough understanding and identifying gaps in IPD practices to the subsequent development of theoretical models, which are then extended to practical applications. Each part builds upon the findings of the previous, demonstrating a logical progression aimed at advancing both the theoretical understanding and practical implementation of IPD.

As detailed in the following subsections, the first article represents the initial step, where the research and development framework for IPD was introduced. This step aimed to identify the constituent parts of IPD, organize the research and development domain, identify gaps in the current IPD framework and practices, and establish a strong foundation for subsequent exploration and development in this study. The second article represents the next step, building on the knowledge established in the first step to develop a capability maturity model for IPD. At this stage, a capability framework for IPD was introduced and then leveraged to develop a maturity matrix and tool specifically designed to evaluate IPD practices at project completion. This tool informs lessons learned and facilitates continuous improvement. Finally, the third article represents the third and last step of this research, introducing a capability readiness model for IPD. Here, the capability framework from the previous step was further developed into a readiness framework and tool, enabling projects to assess their preparedness for implementing IPD. This step enhances the initiation phase of IPD projects, allowing teams to align their efforts and resources for successful implementation.

1.8.1 Article 01: A research and development framework for integrated project delivery (Refer to chapter 2)

The first part focused on developing an overreaching R&D framework to enable structured research and development. This framework captures and organizes the essential theoretical IPD components in a structure that matches its practical implementation, laying the ground for bridging the theory with practice and directly addressing the first part of the research question. This approach helps establish a foundation framework upon which further development steps have been built and, at the same time, provides the framework needed to organize the research conducted on IPD to facilitate identifying the current state and gaps in IPD research and practice.

The resulting R&D framework is built upon established IPD frameworks and a systematic literature review of 175 papers on IPD from 2017 to 2022. It was then validated using data from three IPD case studies. The research findings identified a framework with six primary themes and 19 sub-topics that relate to both` well-explored and under-researched aspects of IPD. Therefore, the R&D framework formed the basis of further scholarly inquiry and practical exploration in charting ways to enhance and optimize the implementation of IPD.

1.8.2 Article 02: A Capability Maturity Model for Integrated Project Delivery (Refer to chapter 3)

Building on the foundation developed through the R&D framework, the research proceeds to formulate the IPD Capability Maturity Model. This second stage moves from broad research mapping to a nuanced identification of IPD capabilities and their indicators in observable behaviors, norms, policies, activities, tools, and practices as seen in real IPD projects. The process resulted in identifying 21 capabilities, categorized into six main sets, providing a robust foundation for developing a practical and applicable maturity model for IPD. This step was followed by developing an IPD capability maturity model (IPDCMM) and a maturity assessment tool (IPD-MAT) that focused on assessing IPD practices' maturity at the project level.

The study combined insights from existing IPD frameworks, maturity models from other fields, and three IPD case studies through staged development. The tool enables an informed evaluation of IPD practices and classifies their implementation maturity into five levels: initial, defined, managed, proficient, and advanced. The tool was then validated via evaluation sessions and feedback interviews with key stakeholders of the case studies. The development of a maturity model addressed the lack of means and mechanisms to properly assess IPD practices and facilitate their continuous enhancement, partially addressing the second part of the research question regarding enabling informed evaluation and continuous improvement of IPD practices.

1.8.3 Article 03: A Readiness Model for Integrated Project Delivery (Refer to chapter 4)

In the third and last part, the capability framework from the previous step was leveraged by validating its applicability at the pre-project phase and building on it an IPD readiness model and a practical readiness assessment tool (IPD-ReAT).

The capability readiness model aims to enhance the project initiation phase by guiding all parties through the critical focus areas necessary for successful IPD implementation. It also offers a structured tool for assessing and improving the readiness for IPD implementation, ensuring that teams, resources, and plans are aligned and capable of achieving the level of collaboration and integration that IPD demands. The tool classifies project readiness into five levels: Emergent, Low, Moderate, High, and Optimal, providing a structured path for assessing and advancing IPD project preparedness.

The tool was applied and validated through two case studies that involved conducting a thorough assessment of their project readiness to start implementing IPD, followed by follow-up interviews with key representatives from these projects. This model completes the answer to the research question, where the readiness and maturity models and their associated tools together enable an informed evaluation of IPD practices and contribute to more standardized and consistent approaches to IPD implementation.

1.8.4 Secondary Contributions

In addition to the main contributions mentioned above, this research journey encompasses several secondary contributions. While these are considered supplementary and are included only in the appendices, they significantly enhance and support the general aim of exploring, understanding, and optimizing this collaborative project delivery system.

- **Conference Paper**: **The Next Era of IPD Research: A Systematic Literature Review of IPD Research Trends 2017-2020 - (Refer to ANNEX I)**:
  This work has initiated an exploration into the domain of IPD through a systematic literature review that focused on the quantitative dimensions of research around IPD. This illuminated the IPD research scope and variability and laid the groundwork for a more focused exploration of IPD within this research.
  Presented and Published in the Creative Construction Conference in 2022.

- **Conference Paper: Integrated Project Delivery (IPD) in Quebec: Exploring Awareness, Perceptions, and Challenges - (Refer to ANNEX II)**:
  This conference paper explores and provides detailed insights into the awareness, perceptions, and challenges related to adopting and implementing IPD in regions still new to this collaborative approach, such as Quebec. The study involved a survey that included more than 90 practitioners from the Quebec construction industry. It provides valuable insight into the policymakers and practitioners of the current state of IPD within the province.
  Accepted and Presented at the Canadian Society of Civil Engineers Conference (CSCE 2024), the proceedings are yet to be published.

- **Conference Paper: Exploring Integrated Project Delivery Through the Lens of Innovation Diffusion Theory: Its Role in Evolving Organizational Practices - (Refer to ANNEX III):**

This paper examined the diffusion of IPD within organizations through the framework of innovation diffusion theory. This study argues that IPD, as an innovation in project delivery, has transformative potential that extends beyond individual projects, influencing broader organizational practices and dynamics. Therefore, the principles of Innovation Diffusion Theory (IDT) were employed to illustrate this impact.
Accepted and Presented at the CSCE Construction Speciality Conference/ ASCE Construction Research Congress (CRC) 2025.

- **Technical Report: Factors Leading to IPD Project Success in Canada:**
  Conducted in collaboration with academic fellows from the University of British Columbia, this report attempted to capture and categorize the success factors leading to effective IPD projects within the Canadian context. It draws on data from three case studies that were pivotal to the development of this dissertation. It represents a significant step in deepening the understanding of the IPD domain and providing an in-depth account of IPD success factors.
  Published online as part of Integrated Project Delivery Alliance Resources in 2022.

- **Technical Report: Ripple Effect: The Role of IPD in Evolving Organizational Practices:**
  In collaboration with academic fellows from the University of Quebec in Montreal, and the University of British Columbia, this study investigated the broader organizational influence of IPD based on a mixed method approach that involved interviews with top management individuals from both public and private organizations and a survey of industry professionals. The study findings revealed various impacts of IPD on organizational practices, highlighting its role in transforming the industry toward more collaborative and integrated practices.
  It will be published online as part of Integrated Project Delivery Alliance Resources.

- **Interactive Online Platform: IPDA Research Synthesis and Diffusion Platform:** In collaboration with academic fellows from the University of Quebec in Montreal and the University of British Columbia, this research project synthesizes and summarizes 116 pieces of IPD research into a format suitable for industry practitioners, aiming to bridge the gap between academic research and practical application in the industry. This work is presented as an interactive online platform that is designed to collect, analyze, and disseminate research on IPD and Lean methodologies across the lifecycle of built assets. The platform aims to provide a structured repository of academic literature for easy access to key insights.

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CHAPTER 2

A RESEARCH AND DEVELOPMENT FRAMEWORK FOR INTEGRATED PROJECT DELIVERY

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2.1 Abstract

Integration and collaboration within construction projects are seen as direct responses to the construction industry's inherent efficiency and performance issues. New project delivery methods, such as Integrated Project Delivery (IPD), have emerged as potential solutions to enable this integration and collaboration and help industry overcome its inherent challenges. The number of studies published on IPD has increased rapidly in recent years, covering many aspects of this innovative approach. However, as IPD is still emerging, a lot of questions remain around its components, their instantiation and more importantly, the areas of research and development needed to support their progression both within academia and industry. This study aims to establish a comprehensive view of the current landscape on IPD research and identify the domains that are underrepresented through the development of an IPD R&D framework. The framework aims to help both researchers and practitioners navigate the different components of IPD and guide research efforts to further their development. In general terms, it aims to help analyze, research, and implement this innovative project delivery approach. The resulting R&D framework is built upon established frameworks and a systematic literature review of 175 papers on IPD research from 2017 to 2022, and was validated using data from three IPD case studies. The research findings identified a framework with six primary themes and 19 sub-topics that relate to both` well-explored and under-researched aspects of IPD.

Keywords: Integrated Project Delivery (IPD); Research and Development Framework; IPD Benefits; IPD Barriers; IPD Success Factors.

2.2 Introduction

Originating in the early 2000s within the United States, Integrated Project Delivery (IPD) emerged as an answer to the shifting demands of the construction sector towards more collaborative approaches to address the mounting challenges in the industry (Allison et al., 2018). According to the American Institute of Architects AIA (2007) and the Canadian Construction Documents Committee CCDC 30 (2018), IPD is defined as a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. This integration is often formalized through a multi-party agreement, focusing on mutual respect and trust, alignment of objectives, and joint risk and reward (Kent & Becerik-Gerber, 2010). This configuration promotes partnership, transparency, and mutual accountability, underscoring that accomplishments are jointly attained and obstacles are collaboratively addressed (Cheng & Johnson, 2016). IPD requires the early engagement of all project team members to ensure that the viability of a project is determined early, target costs are defined, and, vitally, there is a consensus on vision and aims among all team members (AIA, 2007). The anticipated results of such an approach encompass enhanced decision-making, a considerable reduction in change orders, and mitigating common risks associated with the construction processes (Rahim et al., 2015).

IPD's roots can be traced to the relational contracting methods of the 1980s and 1990s, including the Lean Project Delivery System (LPDS), Alliancing contracting, and Partnering. Alliancing contracting, widely recognized in Australia, has been a successful formula for high-risk oil and gas projects. Similarly, Partnering has played a crucial role in addressing challenges within the UK construction industry, particularly in healthcare projects (Raisbeck et al., 2010). These precursors to IPD emphasized features such as multi-party agreements, mutual risk-reward sharing, and fostering collaboration among project participants (Rodrigo, 2012). While elements like the Big Room environment and the use of Building Information Modeling (BIM) are frequently cited as distinctive mechanisms of IPD (Raisbeck et al., 2010), their application within the IPD framework varies depending on the project's complexity and the agreements between involved parties. This variability indicates that these features should not be considered definitive differentiators of IPD from other relational contract forms. Thus, the core of IPD lies in its foundational contractual and operational framework, which promotes collective decision-making and risk-reward sharing and significantly overlaps with other forms of relational contracting, namely Alliancing and Partnering. Despite these commonalities, each method has evolved under different legal and business contexts, influencing their distinct developments (Gransberg & Jeong 2019).

In North America, especially in Canada, IPD has seen considerable adoption, particularly within the public sector. In 2023, over 106 documented projects have employed IPD across Canada, predominantly using contracts like CCDC 30 and the Hanson Bridgett Standard IPD Agreement, specifically tailored or modified to meet Canadian legal and operational standards (IPDA, 2023). Therefore, this paper focuses exclusively on papers and projects that explicitly identify as employing IPD, ensuring a precise and targeted examination of its unique characteristics and impacts on project outcomes. However, the insights drawn are relevant to understanding relational and collaborative project delivery methods in general.

Despite this growing adoption, the shift to IPD is not necessarily straightforward. Besides the necessary change in mindset, there are considerable concrete operational, contractual, and cultural considerations (Simonsen et al., 2019). Transitioning to multi-party agreements can produce unexpected legal complications, especially in places still unfamiliar with such novel contractual arrangements. Additionally, IPD integrates within its operational procedures many innovative and cutting-edge tools and techniques, such as BIM and its many information and model uses, as well as a Lean tools, including the Last Planner System, Target Value Design

(TVD), and A3 Thinking, to name a few, all of which require upfront training for the team members to bridge any knowledge gaps (Teng et al., 2019).

Further complicating the landscape, the traditional practices rooted within the construction industry might cause a reluctance towards adopting this innovative model. This is especially true given the significant shift it demands from the established norms of the industry (Roy et al., 2018). For instance, the model implicates a notable shift in the owner's role from a supervisory stance to a more intensive and continually involved one throughout the project lifecycle, compelling them to either immerse themselves deeply into understanding construction sequences and processes or to engage specialized teams to navigate through these complex, an endeavor not always attainable or attractive for all (Bhonde et al., 2020).

Over the past two decades, IPD has emerged as an effective alternative to traditional project delivery systems, drawing notable attention and discussion manifested in a notable surge in studies that addressed its advantages, challenges, and factors affecting its adoption (Kahvandi et al., 2017). While existing literature has aimed to uncover the various elements of IPD, certain areas still need to be explored, with multiple facets of its potential and challenges remaining ambiguous (Ebrahimi & Dowlatabadi, 2019b; Viana et al., 2020). The significance of a dedicated R&D framework for IPD becomes evident within this context. Given the ongoing growth in the body of knowledge around IPD and the complexities associated with its implementation and adoption, there is an apparent need for a structured approach to IPD research. Recognizing this, a dedicated R&D framework for IPD emerges as a tool that can guide researchers through the multifaceted elements of this innovative approach on one side and as a navigating tool that can bridge the gap between academic research and industry practitioners on the other side.

This research is predicated on determining the gaps and challenges in IPD adoption and implementation to identify and focus on areas that have received less attention by the research community in the past. The aim is to provide a thorough review of IPD research over the last few years and determine a path forward for research and development. Consequently, the research questions are articulated as follows:

- Q1: What is the current state of research and development in the field of IPD and how is it being articulated?
- Q2: How can the constituent parts of IPD be captured and categorized to identify gaps and support research accessibility and analysis?
- Q3: What mechanisms and approaches are needed to enable a structured and consistent approach to R&D on IPD?

The resulting R&D framework is built upon established frameworks and enriched by a systematic literature review of 175 papers on IPD research from 2017 to 2022, with further validation from data derived from three IPD case studies and a panel of experts. Spanning six primary themes and 19 sub-topics, it encompasses various aspects of IPD to ensure comprehensive insight. This framework specifically bridges existing gaps in IPD research and application, and simultaneously fosters a pathway for more directed, coherent, and effective advancements in both academic inquiries and practical implementations in the construction sector.

The study commences by sketching a background through exploring prior IPD frameworks, followed by a detailed account of the research methodology, processes, and validation techniques. The findings from the systematic review are subsequently unveiled, proceeding to a discussion and conclusion detailing the implications and prospective pathways for future IPD research and applications.

2.3 Background

Collaborative delivery mechanisms are an implicit part of the narrative around IPD. Many collaborative delivery models have emerged, which have benefitted from considerable amounts of attention from both a practical and an R & D perspective (Lahdenperä, 2012; Engebo et al., 2020).

Within this approach, models like IPD, Partnering, Design-Build (DB), and Alliancing as well as frameworks such as the Lean Project Delivery System (LPDS) have emerged (Alves &

Shah, 2018b). While IPD, Partnering, and Alliancing focus on strengthening collaboration and increasing operational efficiency through early engagement, mutual trust, and a fair sharing of risks and rewards, DB primarily emphasizes streamlined design and construction processes through single-point responsibility (Engebo et al., 2020). The research frameworks associated with these models tend to dissect the foundational principles, exploring the complexities of integration, collaborative endeavors, and outcomes driven by value. For instance, LPDS , as can be seen in these research frameworks, underlines the importance of reducing waste, maximizing value, and fostering an environment of continual improvement (Forbes & Ahmed, 2010). Similarly, Partnering, as outlined in various research frameworks, fundamentally fosters mutual trust and promotes a collaborative environment. It mainly emphasizes establishing long-term relationships and continual improvement through shared objectives and a sustained collective effort throughout the project lifecycle (Bygballe & Swärd, 2019). Concurrently, Alliancing is architected around a cohesive team environment wherein multiple entities join forces, collectively shouldering risks, accountabilities, and rewards linked to the project's success (Hauck et al., 2004).

Despite their apparent similarities, Partnering and Alliancing's frameworks reveal distinct approaches that govern their application in construction project management, especially in the contractual obligations, risk and reward sharing, and operational frameworks. Partnering tends to prioritize collaborative relationship-building and cooperation over formal contractual ties, offering a flexible approach to financial planning without obligating a risk-reward sharing model. On the other hand, Alliancing brings entities together under a formal multiparty contractual framework, mandating risk-reward sharing, and binds participating entities into a single operational unit (Walker et al., 2002).

Research on IPD has been traditionally developed from two perspectives : theoretical frameworks and practically oriented frameworks (Kahvandi et al., 2017). Research frameworks specific to IPD, have delved into the theoretical underpinnings, foundational components, and interactions associated with IPD. Their primary goal is to impart a holistic comprehension rooted in fundamental principles, classifications, and inherent interconnections (Green, 2013). For instance, Aslesen et al., (2018) framed a detailed architecture, shedding light on how the first Norwegian IPD project adeptly handled the salient components of IPD. They positioned IPD as a strategic delivery model that boosts collaboration across construction project stakeholders. A key revelation from their findings was that fortified collaboration acts as a catalyst for project teams, amplifying their innovation capacity and ensuring effective project implementation. Their proposed framework methodically segments the theoretical facets of IPD into three distinct categories: contract, technology and processes, and culture. Herein, both the contract and culture dimensions serve as the bedrock for fostering collaboration, while the technology and processes elements act as the tools for efficient project delivery. In a parallel vein, Fischer et al. (2014) introduced another research-centric model named "The Simple Framework." This model encapsulates an optimal approach for integration with a vision of executing high-performance facilities. It is composed of five core segments: integrated information, integrated organization, integrated processes, and integrated building systems.

However, there's a contrasting perspective. For industry professionals seeking actionable insights for IPD application, the aforementioned research frameworks might lack a methodological guide to implement IPD. This is where the utility of practical frameworks becomes more pronounced.

In this regard, practical frameworks crafted for these collaborative delivery methods offer actionable tools, methodologies, and procedural blueprints. They are designed for tangible applications of IPD (Heaslip et al., 2016). They emphasize operational aspects, providing actionable methodologies to implement, in this case, IPD in real-world construction scenarios effectively. For instance, in models like Partnering and Alliancing, the range of emphasis covers areas such as governance , integrated team structure, performance matrices, and risk and rewards sharing mechanisms linked to tangible outcomes (G. Chen et al., 2012).

Regarding practical IPD frameworks, The Guide, A.I.A (2007), highlighted by some as a pioneer guide, was a foundational initiative aimed at decoding the operational complications associated with IPD. Furthermore, Ashcraft (2012) endeavored to frame the essence of IPD through a dual framework:

- The Macro-Framework explains contract terms and business configuration, including elements such as documentation, objectives, stakeholder relationships, measurements, and outcomes.

- The Micro-Framework is more nuanced and delves into the protocols and strategies tailored to mitigate operational challenges. This covers a spectrum of areas including, but not limited to, work design, information design, and team formation strategies.

Complementing this, Allison et al. (2018), leveraging the expertise of industry experts, formulated a robust practical framework. Presented as a comprehensive guide for IPD, this framework touches upon various aspects that cover the entire IPD implementation processes, like project structuring, team composition, decision-making process, communication channels, risk mitigation strategies, and performance evaluative metrics.

Beyond the aforementioned frameworks, two complementary frameworks have been brought to light through industry reports; (R. Cheng & Johnson, 2016) and (Poirier et al., 2022). Both provided a detailed illustration of IPD's various elements and were reviewed by North America's industry experts.

In their thorough investigation to capture the motivations and means foundational to IPD's success, Cheng & Johnson (2016) developed a set of indicators termed "markers." These were devised from a rigorous workshop methodology, engaging participants from 10 distinct IPD projects, nine from the USA and one project from the Canadian construction market. These markers represent the different stages of IPD processes, offering insights into the factors underpinning the success of IPD projects. Each of those markers was categorized under one of six categories: Context, Legal/Commercial, Leadership/Management, Processes/Lean, Alignment/Goals, and Building Outcomes.

Building on Cheng & Johnson's foundational work, Poirier et al. (2022) restructured these markers to attain a more systematic flow, reflecting their investigation of IPD's success factors in the Canadian construction industry. Their categorization aimed to align more seamlessly with the IPD processes, emphasizing the pivotal components supporting IPD's effective implementation. Their revised categories enclose: Making the Case for IPD, Framing the Project, Choosing the Team, Setting the Context, Executing the Work, Maintaining Excellence, and Reaping the Benefits.

As evidenced above, the current IPD domain heavily leans towards practical frameworks. This inclination can be understood given IPD's industry-driven nature and the consequent research endeavors that are striving to keep pace. However, such an imbalance underscores an apparent gap: a lack of research and development R&D frameworks for IPD. Landing on this gap was informed by the fact that while the practical frameworks excel in the application, they often lack a structured approach to integrating these practices with broader theoretical underpinnings that could influence the field and inform long-term strategic developments and innovations, especially since they focus on operational efficiency, addressing specific project challenges, and optimizing direct outcomes (Nilsen, 2015).

Similarly, examining the limited number of theoretical frameworks available revealed that although they are detailed and elaborative on the foundational components of IPD, they are not always aligned with or not meant to be aligned with the practical applications, pointing to the same gap in bridging between theory and practice (Green, 2013).

Recognizing these shortcomings emphasizes the need for further structured research and development in IPD to ensure that both theoretical insights and tangible practices are well-addressed and continue to evolve in the industry.

Introducing a dedicated R&D framework will facilitate a more holistic understanding of the existing knowledge and the practical implications of theoretical research. The framework will illuminate areas within IPD that require further exploration. Identifying these zones of opportunity can channel efforts more effectively, leading to refined best practices and addressing challenges that have yet to be fully understood. In essence, developing an R&D framework is not just an addition; it is necessary to bridge gaps, foster innovation, and enhance the overall potential of IPD.

2.4 Methodology

This study aims to develop a framework to support a structured investigation into IPD R&D and highlight any underrepresented areas that require further exploration. At the core of the methodological approach is the systematic combining process, which facilitates the integration of diverse data sources. This can ensure that the development of the R&D framework is both robust and reflective of real-world complexities. In particular, systematic combining allows for a dynamic interplay between theory and empirical data, ensuring a continuous adjustment of the theoretical framework as new data and insights emerge without constraining the scope of discovery by sticking rigidly to initial hypotheses; this kind of adaptability is particularly relevant in the context of IPD, where a limited number of frameworks are available to guide the development process, as shown in the background section. Therefore, the systematic combining process represents, within the context of this study, an integrated approach that serves as a dynamic method to synthesize diverse perspectives and data sources into a coherent and comprehensive R&D framework that effectively represents the IPD landscape (Dubois & Gadde, 2014). As shown in **Figure 2.1**, the methodology unfolds through three interlinked stages: 1) Development of a preliminary R&D framework, 2) Conducting a systematic literature review, and 3) The central systematic combining process, which merges emergent codes from the literature review with insights from the preliminary framework, enhanced by practical inputs from case studies and expert evaluations.

2.4.1 Preliminary R&D Framework Development

The aim of the first stream was to establish a foundation and structure for understanding the components of IPD that accurately reflect its phases, activities, and structure. This preliminary framework would serve as a starting point for building a comprehensive R&D framework when integrated with subsequent steps of this methodology.

The R&D framework is built upon a review of relevant research and practical frameworks, as

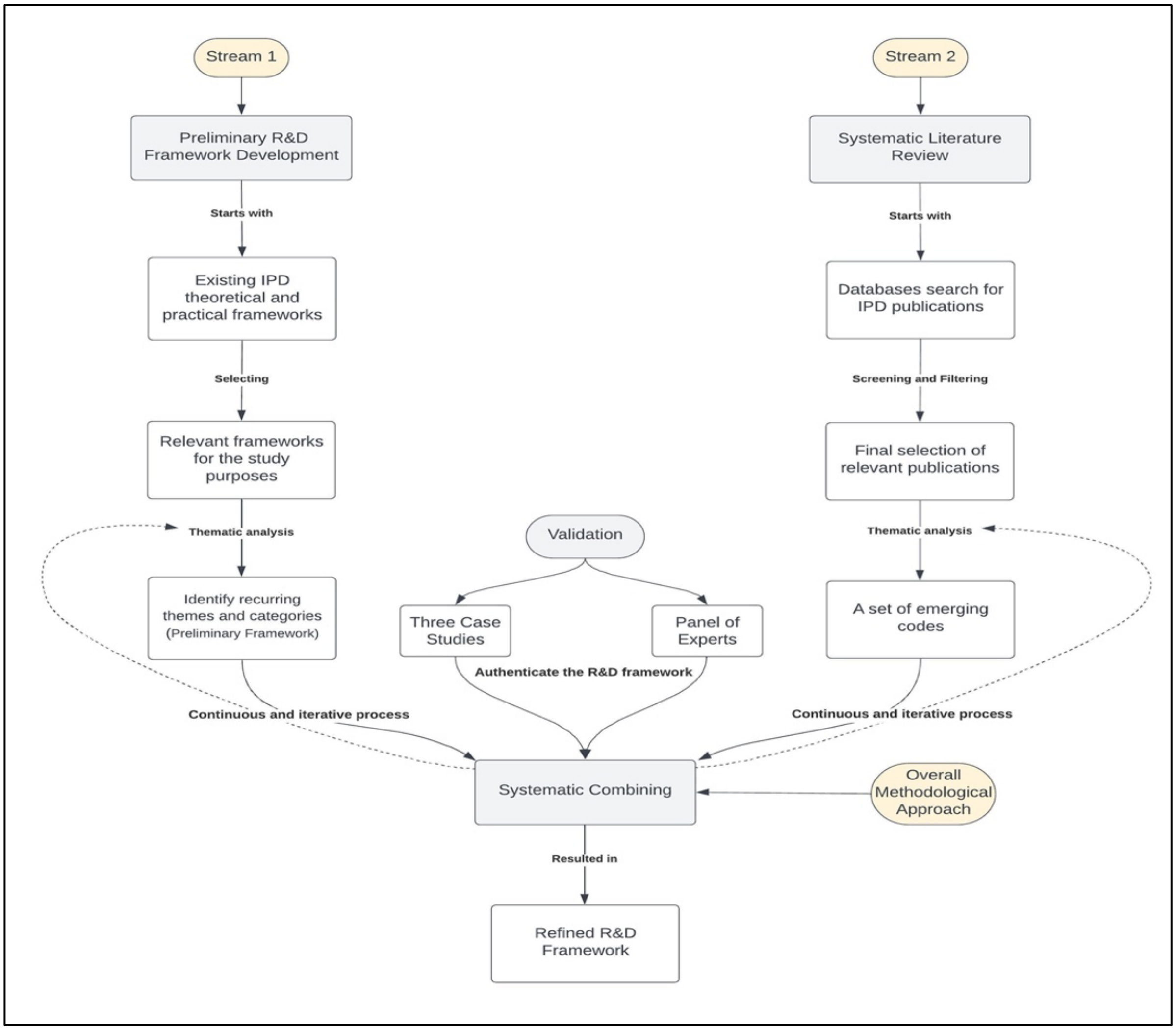

Figure 2.1 Methodology flowchart

detailed in the background section. Despite the limited availability of comprehensive IPD frameworks, this step focused on synthesizing knowledge from those few that were available. Specifically, the frameworks by Cheng & Johnson (2016), Allison et al. (2018), and the Integrated Project Delivery: a guide by A.I.A (2007) were instrumental in the preliminary development of our framework. These frameworks were selected for their holistic approach to IPD, providing valuable insights into the varied aspects of IPD, forming a solid base from which a structured understanding could be built. In particular, Cheng & Johnson (2016) were selected due to their in-depth and structured presentation of IPD, specifically focusing on identifying success factors across various IPD project phases. The guidelines provided by

Guide, A.I.A (2007) were selected for their pioneering efforts in detailing IPD processes and procedures; they were seen as the starting point of the research trend around IPD (Kahvandi et al., 2017; Arar & Poirier, 2022). Similarly, Allison et al. (2018), in their work, Integrated Project Delivery: An Action Guide for Leaders, offers a comprehensive guide that involves practical strategies and leadership insights. Their approaches have resonated and remain referential in the IPD domain.

Utilizing thematic analysis, an iterative process was used to examine these works, allowing the extraction and merging of recurring themes and crucial insights found within them. Thematic analysis, as a qualitative methodology, allows for a granular identification, examination, and interpretation of emerging patterns within vast data sets (Braun & Clarke, 2006). Therefore, each source was thereby thoroughly analyzed and cross-referenced.

The process highlighted various components of IPD along with their overarching contexts. At this juncture, these components were systematically organized into themes and corresponding categories, laying a foundation for the subsequent development stages. Throughout the thematic analysis, the identified topics were evaluated to ensure their direct contribution to the understanding or implementation of IPD. This evaluation process was characterized by:

- Direct relevance to the phases, practices, or outcomes of IPD projects.
- Presence in multiple IPD case studies or among the discussions of IPD published research.
- The potential to impact the success, efficiency, or effectiveness of IPD projects, as supported by existing research.

This approach ensured that all themes and categories derived from the thematic analysis were relevant to the core objectives of advancing IPD knowledge and practice. This structure was designed with flexibility in mind to allow for expansion during the systematic combining process. Consequently, the preliminary R&D framework was developed, comprising six themes and 19 categories, each reflecting the detailed examination and synthesis of the results. The preliminary R&D framework's first layer, the themes, matches, to a certain degree, the themes presented in Cheng & Johnson (2016), while the second layer, the categories, incorporated many IPD processes as it was detailed in Allison et al. (2018) and Guide, A.I.A (2007).

2.4.2 Systematic Literature Review

The aim of the second stream was to conduct a systematic literature review to capture the state of IPD research within the specified timeframe, identify the key topics and areas addressed, and understand the specific contributions of each paper to the field. Although the systematic review involved carefully analyzing the content of the selected papers, its purpose was not to discuss the papers' content in detail but rather to label their immediate areas of contribution, which would later serve as building blocks for the final R&D framework.

Utilizing a systematic literature review is recognized for its capability to provide comprehensive and unbiased overviews (White & Schmidt, 2005; Snyder, 2019). Initial searches encompassed a broad array of academic databases, including ASCE, EI Compendex, Inspec, Knovel, IEEE, Science Direct, Springer Link, Wiley online library, ProQuest-Advanced Technologies & Aerospace Collection, and more. "Integrated Project Delivery" and "IPD" were identified as the primary keywords in the search strategy. Recognizing the potential for key literature to be associated with related concepts, the search was expanded to include terms like "Collaborative Project Procurement," "Relational contracting," and "Project delivery systems."

The inclusion and exclusion criteria were predefined to guide the review. Specifically, the research narrowed its scope to target publications in the construction sector, peer-reviewed journals, or conference papers within the window of 01-01-2017 to 31-12-2022 and confined to English. This strategic approach ensured a balance between breadth and relevance.

The first round of reviews resulted in 1361 publications being moved through to the next stage of the research. The papers were then sorted and screened to eliminate any duplicates. This step initially yielded 747 publications. An examination of each publication's title and abstract was conducted to identify and exclude irrelevant studies. This examination was crucial as the pool included a significant number of papers from entirely different industries or fields and still appear in the results of running the search terms. Additionally, some papers used the same acronym, "IPD," but referred to entirely different topics, such as Integrated Product Development. This process, primarily guided by the review of titles and, when necessary, abstracts, led to the exclusion of 569 papers, leaving only those that specifically discussed Integrated Project Delivery within the construction industry. After further exclusion of publications not in English, the total number of publications deemed relevant and included in this study was narrowed to 175, as shown in **Figure 2.2.**

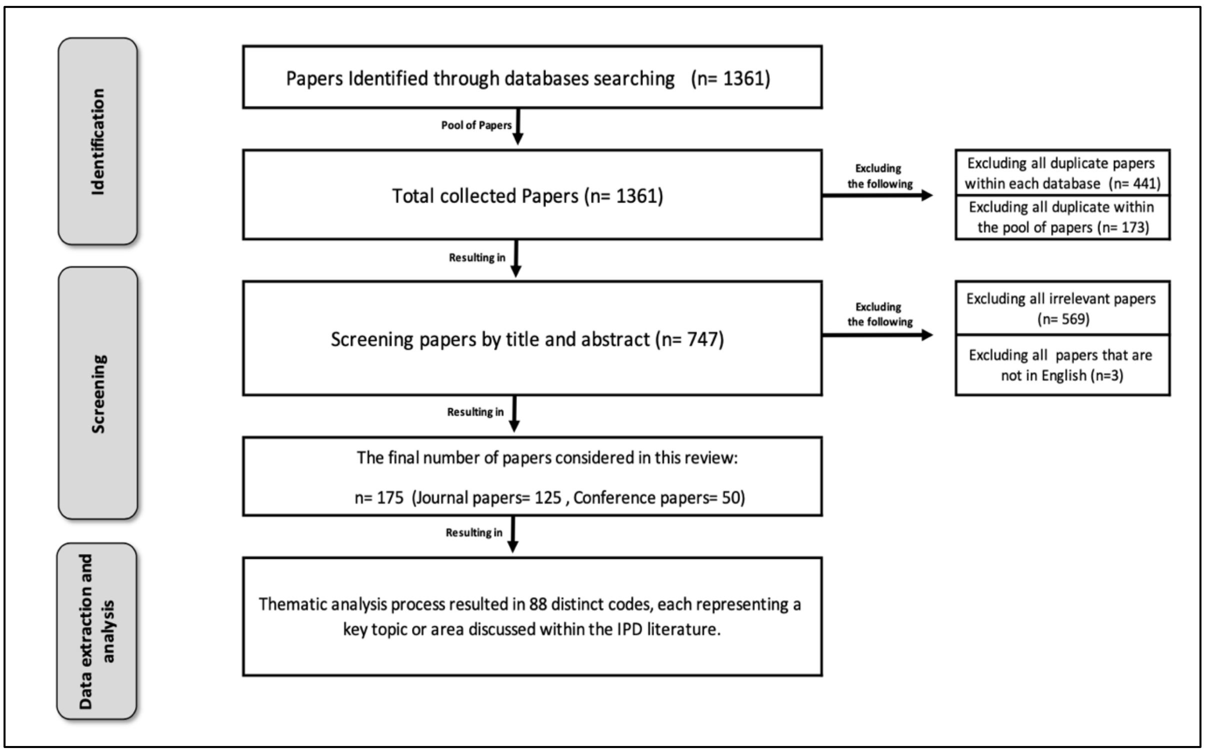

Figure 2.2 Systematic Literature Review Process

Out of the selected 175 papers, 125 were journal papers, 50 were conference papers, and twelve were literature reviews, which were later excluded from the framework development to avoid redundant thematic overlaps. Following this, a detailed thematic analysis was conducted to find patterns and connections between the topics discussed in the IPD papers and better grasp what was covered during the period in question.

The data analysis included labeling the papers based on the primary topics covered in each publication. This was done by thoroughly reading each manuscript and identifying each study's immediate area of contribution. Finally, the labels and contribution areas found were used to develop codes representing whatever component of the IPD processes and procedures each article was concerned with. This process was carried out on NVivo, where 88 unique codes emerged, each representing a distinct aspect discussed within the IPD research. These codes became the building blocks for the refined IPD R&D framework in the subsequent step.

2.4.3 Systematic Combining Process

To shape the final and refined R&D framework, a systematic combining approach that included a continuous and iterative process was applied to integrate multiple layers of data and insights. This involves the codes that emerged from the thematic analysis of the selected papers, the themes and categories supplied by the preliminary framework, and validation inputs from three case studies and expert panel evaluations. This multilayered interplay ensured the framework's robustness and relevance to actual industry practices. The primary aspect of this systematic combining approach is constant movement and switching back and forth between the framework, data sources, and analysis (Dubois & Gadde, 2002). This allows for the flexibility necessary to adapt and evolve during the research process, especially in developing a framework for a relatively new yet complex concept like IPD.

The components that were integrated through a continuous and iterative process of the systematic combining approach are the following:

- **Themes and Categories from the Preliminary Framework:** Established in the initial phase of the research, these elements provided a structured outline of IPD's essential components and phases.
- **Emergent Codes from the Systematic Literature Review:** These codes, identified through thematic analysis of the selected IPD literature, highlighted the current research focuses and topics addressed.
- **Validation Inputs from Case Studies and Expert Panel**: As detailed in the validation section, a validation entity that included three detailed case studies and

insights from a panel of 19 IPD experts played a critical role in the development process within the systematic combining approach. This validation entity helped to validate and adjust the themes and categories within the framework, ensuring they accurately reflect the nuances and complexities of IPD implementation.

This process began with evaluating each code against the existing preliminary framework and determining points of convergence. Codes corresponding to a specific category within the six themes were seamlessly integrated. Conversely, codes that posed challenges or lacked a precise fit were reconsidered. This involved revisiting the literature, seeking further clarifications from case studies, or incorporating additional insights from the expert panel.

This dynamic process facilitated the mutual reinforcement of theoretical constructs and practical observations. At times, the emergent codes from the literature review were confirmed by the case studies, which offered real-world narratives about how IPD is implemented in projects, underscoring their relevance and providing a more complete picture of their practical implementation. Conversely, the case studies sometimes revealed essential aspects of the IPD framework that appeared under-researched in the literature, which therefore points to a potential aspect to be included in the framework while also directly pointing to a gap in research. The same dynamic was experienced with the panel of experts; however, at a higher level, their interaction continually validated and authenticated the comprehensive capture of a complete picture of IPD in the framework through their continuous review of the themes and categories that emerged from the process. This process ensured that the resulting refined R&D framework truly reflected the evolving IPD domain and comprehensively represented IPD's approach and associated research.

2.4.4 Validation

2.4.4.1 Research protocol validation

The review protocol was verified in two steps. The aim of the first step was to confirm the review protocol and process. Two specialized librarians from the École de technologies supérieure were given the review protocol and the detailed research process to evaluate. Then, a meeting was held to address the process specifics, which then led to a revised version of the study protocol.

In the next step, the review protocol, process, and selected publications were explained to an external validator. The validator randomly chose 15% of the publications, extracted the necessary data, and classified them. The findings were compared to the researcher's results and 85% of the extracted and coded data was identical. The researcher explained the discrepancies and returned the data for a second round of validation. The validator answered the researcher's reasoning again and a 98% match was reached. The logic from this exercise was then applied to the rest. These steps were taken to ensure a rigorous systematic review process, that delivers validated results.

2.4.4.2 Framework validation

The validation of the R&D framework was an integral part of its development, and it manifested in a research project initially conducted with an emphasis on investigating the success factors of IPD in the Canadian construction industry, which acted as the verifying entity for the framework. This approach included two different but complementary strategies: First, an academically structured research project fanned by analyzing empirical data from three IPD projects. Second, by actively engaging with a panel of experts knowledgeable in IPD projects, whose insights were sought and incorporated at various points throughout the project.

- Empirical Validation through Case Studies:

The three case studies provided a valuable depth to analysis, each contributing distinct perspectives and data that were crucial for refining and validating the R&D framework. The first case involved the renovation of a municipal aquatic facility in British Columbia, focusing on resilience, energy efficiency, and reducing greenhouse gas emissions. The second case centered around constructing two state-of-the-art educational facilities in Alberta, designed with modern educational philosophies and architectural innovation at their core. The third case examined the development of a shared infrastructure in Ontario to facilitate collaborative environments for first responder agencies. Together, these cases contributed 37.7 hours of stakeholder interviews, insights from a survey that included 36 responses from the team, and a review of over 100 project documents. This rich dataset helped, through the systematic combining process, fine-tune the framework elements to reflect real-world complexities and operational realities. The data provided an enriched research environment that, albeit providing practical application insights, primarily served to authenticate the R&D framework through a research-oriented lens.

- Expert Panel Review:

A panel comprising 19 experts with extensive knowledge of IPD significantly contributed to the validation process. This diverse group, including representatives from owners, contractors, engineering and consulting firms, and specialized contractors, originally served on a research and performance committee for a non-for-profit promoting collaborative construction in Canada. During the systematic combining process, the framework's themes and categories were verified and commented upon, with the panel scrutinizing their sequence, logic, and how well they reflect the actual phases and steps of IPD projects.

In the course of refining the framework, several shortcomings and gaps were identified and subsequently addressed. For example, the processes within the 'Framing the Project' theme necessitated a more detailed tracing. The data underlined a sequential protocol, beginning with team selection, transitioning into a 'Validation' phase, wherein preliminary designs guide budget determinations, and ultimately concluding with the drafting of the contract. This identified sequence was reflected in the framework. In another example, due to the emphasis on risk management in the case studies and the appearance of risk codes in the literature's thematic analysis, the "Optimizing excellence" theme was enriched by including a risk management category.

2.5 Results

At the onset of the research project, the aim was to establish a comprehensive understanding of the landscape of IPD research, reveal the areas that required further research, and determine a path forward for research and development. To achieve this goal, a dedicated R&D framework was developed to outline prospective directions to develop knowledge pertaining to IPD.

As detailed in the methodology section, the study started by introducing a preliminary R&D framework that comprises six themes and 19 categories, each reflecting the detailed examination and synthesis of the obtained insights from a set of established IPD frameworks. This preliminary framework offers a solid foundation for understanding the components of IPD and serves as a starting point for building a comprehensive R&D framework. **Table 2.1** details the elements of the preliminary R&D framework, offering a broad view into the themes and their related categories, arranged with a description of specific concerns of each of them. It's important to note that the final form of themes and categories was not defined until the third step of employed methodology completed, where the preliminary R&D framework continuously interacted with the other data sources in the systematic combining process.

Table 2.1 Preliminary R&D framework

#	Themes	Description	Categories	Description
1	**Choosing IPD**	Centered around the driving factors that influence the decision to adopt IPD and the barriers that hinder that adoption.	**IPD drivers for success**	Focuses on the influential factors that drive the successful implementation of IPD and, therefore, encourage its adoption.
			Adoption barriers	Includes the barriers and challenges to IPD adoption.
2	**Framing the project**	Focuses on the foundational elements essential for the formulation and initiation of an IPD project.	**Developing the contract**	Contains the different aspects of IPD contracts, such as contract types, clauses, and negotiation.
			Team selection	Centered around the formation of an integrated team that can collaborate effectively.
			Validation	Encloses the methods and approaches to design and verify the feasibility and viability of the IPD project.

Table 2.1 Preliminary R&D framework (continued)

#	Themes	Description	Categories	Description
3	**Setting the context**	Addressing the policies and procedures necessary for governance and the efficient execution of IPD projects.	**Facilitation IPD**	Converges on the methods, strategies, and tools that are used in streamlining and enhancing the implementation of IPD.
			Roles and responsibilities	Focuses on the roles and responsibilities and how they evolve in IPD projects.
			Decision structure	Devoted to the various aspects of the decision-making process established within IPD projects.
4	**Executing the work**	Centered around practical methods and strategies for ensuring an efficient implementation of an IPD project.	**BIM**	Focuses on the integration between IPD and BIM and its role in enhancing IPD projects' implementation.
			Lean	Devoted to the integration of lean concepts and tools with IPD.
			Big room	Spotlights the strategy of bringing all team members within a collaborative physical or virtual space to strengthen communication and collaborative efforts.
			Prefabrication	Focuses on the facilitation and the utilization of prefabrication within IPD projects.
			Implementation performance and challenges	Delves into the empirical aspects of IPD implementation, highlighting the benefits and challenges from the perspectives from real IPD projects.
5	**Optimizing excellence**	Focuses on maximizing the efficiency and effectiveness of an IPD project by concentrating on collaboration, integration, team alignment, and risk management.	**Collaboration**	Centered around the collaboration role within IPD projects, including its impact and the strategies and technologies that facilitate it within IPD.
			Integration	Delves into the integration feature in IPD, its advantages, and the development of integrated teams.
			Team alignment	Focuses on the measures and strategies to align the objectives of all team members and ensure collective commitment.
			Risk management	Includes potential risks and challenges within IPD projects and risk management strategies.
6	**Reaping the benefits**	Centered around the direct and indirect benefits that stem from IPD implementation.	**Profits and payout**	Devoted to profit distribution and incentives payout strategies within IPD.
			Benefits of IPD	Focuses on the advantages and the enhancement realized in construction projects implementing IPD.

With the preliminary framework as a baseline, an exhaustive literature review was then undertaken, resulting in the selection of 175 papers (125 journal papers and 50 conference papers). This review was pivotal in determining the current state of IPD research, highlighting the key topics and immediate contributions of each paper to the field of IPD. Through a thematic analysis, the patterns and connections between the topics discussed were established and formed in the shape of codes. These codes were systematically integrated with the preliminary R&D framework and further enriched by insights from three detailed case studies and an expert panel through a systematic combining process, as outlined in the methodology section. The outcome of this process is represented in the refined R&D framework, which conceptualizes the components of IPD and organizes them into a comprehensive model, designed to incorporate the theoretical components of IPD research into a practical structure that speaks to the implementation phases of this approach. The refined R&D framework is organized into six distinct themes, 19 categories, and 88 corresponding codes.

2.5.1 Choosing IPD

Choosing IPD as a project delivery system was the most studied topic, covered in 37 papers. This theme focused on the selection of IPD, considering various success drivers and addressing barriers to its adoption.

IPD drivers for success

Seven publications outlined drivers for success in IPD, highlighting essential factors that enhance the likelihood of project success and motivate the utilization of this approach. **Table 2.3** consolidates these key drivers, which include early goal definition, shared responsibilities, risk-sharing, an effective process for managing change orders, and team member empowerment (Jung Ho Yu et al., 2019; Whang et al., 2019), all of which have been linked to various project performance aspects influencing IPD implementation.

Table 2.2 Refined IPD R&D Framework and Codes frequency

Themes	Categories	#	Codes	Files	Ref.	#	Codes	Files	Ref.
Choosing IPD	**IPD drivers for success**	C1	Alignment of interest	6	6	C9	Facilitating innovation	20	33
		C2	Appropriate contract development	4	4	C10	Financial incentives	10	35
		C3	Collaborative decision-making	30	70	C11	Fiscal transparency	16	25
		C4	Early goal definition	10	15	C12	Good communication atmosphere	2	4
		C5	Early involvement of the stakeholders	7	9	C13	Integrated design process	6	7
		C6	Effective owner's involvement	5	8	C14	Reducing waste	13	17
		C7	Effective process for handling change orders	3	4	C15	Risk-sharing	41	14 3
		C8	Empowerment of the team members	1	1	C16	Shared responsibilities	10	30
	Adoption barriers	C1	Clients do not recognize the advantages	1	1	C24	Lack of IPD knowledge	18	34
		C1	Complexity of implementation of IPD	2	6	C25	Legal & Contractual hardships	7	7
		C1	Current cultural and behavioral attitudes	2	2	C26	Resistance to change	12	31
		C2	High initial cost	2	2	C27	Seeking for the lowest cost	1	10
		C2	Lack of evidence of ROI for stakeholders	1	1	C28	Unfamiliarity with BIM	1	3
		C2	Lack of government support	3	3	C29	Unwillingness to share profit	1	1
		C	Lack of interest	3	7				
Framing the project	**Developing the contract**	C	Change order process	1	4	C33	IPD agreements	8	25
		C	Contractual elements	5	30				
	Team selection	C3	IPD's organizational structure	1	2	C34	Team performance competencies	2	3
	Validation	C	Validation process	5	12				
Setting the context	**Facilitation IPD**	C3	Adequate facilitation	4	5				
	Roles and responsibilities	C3	Control activities	2	2	C38	Restructuring project roles	2	2
		C	Governance structures	2	24				
	Decision structure	C4	Decision-making effectiveness	2	4				
Executing the work	**BIM**	C4	BIM-IPD adoption barrier	2	2	C43	BIM-IPD integration models	13	47
		C	BIM-IPD integration benefits	6	6				
	Lean	C4	Lean tools	2	2	C45	Lean-IPD integration	3	3
	Big room	C	Big room challenges	23	63				
	Prefabrication	C4	Facilitating prefabrication	16	101				

Table 2.2 Refined IPD R&D Framework and Codes frequency (continued)

Themes	Categories	#	Codes	Files	Ref.	#	Codes	Files	Ref.
	Implementation performance and challenges	C48	IPD implementation challenges	2	3	C49	Performance indicators	1	1
Optimizing excellence	**Collaboration**	C50	Collaboration triggers	19	32	C51	Collaboration within integrated contracts and project delivery systems	5	7
	Integration	C5	Integration advantages	3	5	C53	The development of integrated teams	5	5
	Team alignment	C5	Team alignment in IPD projects	3	3				
	Risk management	C5	Risk management in IPD projects	3	4				
Reaping the benefits	**Profits and payout**	C5	Cash flow management	1	5	C58	Profit distribution	13	117
		C	Incentive mechanisms	8	19				
	Benefits of IPD	C	Owner satisfaction	2	2	C	Less schedule growth	1	1
		C6	Achieve better value for money	1	1	C75	low pursuit cost	1	1
		C6	Better owner risk control	1	1	C76	Reduce change order processing time	3	9
		C6	Early detection of clashes	1	1	C77	Reduce decision-making time	1	1
		C6	Employee-pleasant working conditions	1	1	C78	Reduce design related change	2	3
		C6	Enable fiscal transparency which fosters trust	1	1	C79	Reduce number of deficiency issues	2	4
		C6	Foster strong relationships between team	1	1	C80	Reduce number of RFI	2	2
		C6	Higher team integration and collaboration	2	2	C81	Reduce number punch-list items	2	6
		C6	Improve the buildability of the design	1	1	C82	Reduce project overall change	3	3
		C6	Improve the overall performance of the project	4	4	C83	Reduce quality and value-related change	2	2
		C6	Improve the owner-contractor relationship	1	1	C84	Reduce RFI processing time	3	11
		C7	Increase overall project systems quality	3	3	C85	Reduce the total duration of the project	4	4
		C7	Increase ownership among project members	1	1	C86	Reduces Risk	4	4
		C7	Facilitate constructability and increase productivity	2	3	C87	Reduces the total cost	4	7
		C7	Less cost growth	2	2	C88	Reducing the waste in the construction phase	1	1

IPD has proven effective for executing sizable, intricate projects, attributed to factors such as interest alignment, an integrated design approach, and preliminary stakeholder engagement

(Esther Paik et al., 2017; Rochette, 2018). Notably, the Mount Sinai Brooklyn Hospital and Montreal's Biodome nature museum achieved reduced energy costs utilizing IPD practices like collaborative design and financial incentives (Xie & Liu, 2017). Elements like collaborative decision-making and fiscal transparency also emerged as vital (Aslesen et al., 2018; Khanna et al., 2021).

Table 2.3 IPD drivers for success

#	Success factors	(Jung Ho Yu et al., 2019)	(Rochette, 2018)	(Esther Paik et al., 2017)	(Xie & Liu, 2017)	(Whang et al., 2019)	(Aslesen et al., 2018)	(Khanna et al., 2021)
1	Risk-sharing	✓						
2	Alignment of interest	✓	✓	✓			✓	
3	Early goal definition	✓				✓		
4	Collaborative decision-making process	✓		✓			✓	
5	Shared responsibilities	✓			✓	✓		
6	Integrated design process	✓	✓			✓		
7	Appropriate contract development	✓				✓		
8	Good communication atmosphere	✓			✓		✓	✓
9	Fiscal transparency	✓						✓
10	Reducing waste	✓						
11	Early involvement of the stakeholders	✓	✓	✓				
12	Effective process for handling change orders	✓						
13	Financial incentives				✓			
14	Effective owner's involvement					✓		
15	Empowerment of the team members	✓				✓		

Additionally, IPD promotes innovation, especially in employing Building Information Modeling (BIM) and practices like Lean and prefabrication, supported by frequent academic references.

Several studies emphasized IPD's facilitation in adopting BIM by addressing collaborative challenges, enhancing early stakeholder involvement, and fostering trust (A. Fakhimi et al., 2017; A. H. Fakhimi et al., 2018; Ariffin et al., 2017; Lucarelli et al., 2019; Pengfei Li et al., 2019). Improving early involvement of key players, increasing trust, and removing barriers to collaboration were ways IPD ensured broader and more comprehensive use of BIM (Hajj et al., 2021; Piroozfar et al., 2019). While one study (Chang et al., 2017) highlighted a positive correlation between BIM implementation and IPD acceptance, another indicated potential cultural and financial hurdles in specific industries, like Turkey's AEC sector (Ozener et al., 2020).

Adoption barriers

Adoption barriers were the subject of 21 papers, making it one of the most researched topics. 13 key challenges to IPD adoption were identified, including legal and contractual barriers, a lack of knowledge of IPD, and resistance to change (see **Table 2.4**). These barriers were primarily identified in studies examining specific construction markets, including Malaysia (Durdyev et al., 2019), China and Singapore (N. Zhang et al., 2020; Li & Ma, 2017; Q. Ma et al., 2022), India (Charlesraj & Gupta, 2019), Lebanon (Dargham et al., 2019), Peru (Gomez, Ballard, et al., 2018; Kumar, 2022), South Africa (Govender et al., 2018), Egypt and Saudi Arabia (Sherif et al., 2022; Alqahtani et al., 2022), Kuwait (Buk'hail & Al-Sabah, 2022), and a case study from the U.S. (Leicht & Harty, 2017). Only (De Marco & Karzouna, 2018) examined barriers from a transnational perspective.

Despite the documented successes of IPD, its widespread adoption across the construction sector remains a future prospect rather than a present reality (Hall & Scott, 2019). The journey toward overcoming the barriers to IPD adoption is marked by significant challenges that demand comprehensive organizational transformation. This includes acknowledging the need for a realistic timescale and securing an unwavering commitment from senior leadership (Aldossari et al., 2020).Although tools and frameworks aimed at facilitating IPD adoption, such as those proposed by Ahmad et al., (2019) and Vaitla et al., (2022) focusing on company capability assessment and resource management, offer valuable insights, they also underscore the complexity of integrating such innovative approaches within existing industry structures.

Some attempts to navigate IPD complexities, such as a competence-oriented game by Russmann et al., (2022) and the application of blockchain technology for enhancing financial transparency in IPD projects (Elghaish, Abrishami, & Hosseini, 2020), represent novel solutions to navigate IPD's multifaceted challenges. However, these innovations also highlight the broader issue of technological and managerial integration in an industry often characterized by its resistance to change. The use of blockchain to address common pool resource (CPR)

Table 2.4 IPD adoption barriers

#	IPD barriers	References
1	Resistance to change	(Charlesraj & Gupta, 2019), (N. Zhang et al., 2020), (Leicht & Harty, 2017), (Govender et al., 2018), (Sherif et al., 2022)
2	High initial cost	(De Marco & Karzouna, 2018), (Dargham et al., 2019)
3	Lack of IPD knowledge	(Charlesraj & Gupta, 2019), (Li & Ma, 2017), (Dargham et al., 2019), (Gomez, Ballard, et al., 2018), (Govender et al., 2018), (Sherif et al., 2022), (Q. Ma, Li, Teo, et al., 2022), (Russmann et al., 2022), (Alqahtani et al., 2022)
4	Current cultural and behavioral attitudes	(Dargham et al., 2019), (Gomez, Ballard, et al., 2018), (Kumar, 2022)
5	Legal and Contractual hardships	(De Marco & Karzouna, 2018), (Li & Ma, 2017), (N. Zhang et al., 2020), (Dargham et al., 2019), (Leicht & Harty, 2017), (Gomez, Ballard, et al., 2018), (Q. Ma, Li, Teo, et al., 2022), (Buk'hail & Al-Sabah, 2022), (Alqahtani et al., 2022)
6	Unfamiliarity with BIM	(Charlesraj & Gupta, 2019)
7	Complexity of implementation of IPD	(De Marco & Karzouna, 2018), (Durdyev et al., 2019), (N. Zhang et al., 2020)
8	Lack of government support	(Li & Ma, 2017), (Kumar, 2022), (Alqahtani et al., 2022)
9	Lack of interest	(Li & Ma, 2017), (Durdyev et al., 2019), (N. Zhang et al., 2020)
10	Clients do not recognize the advantages	(Govender et al., 2018)
11	Seeking for the lowest cost	(N. Zhang et al., 2020)
12	Lack of evidence of ROI for stakeholders	(Durdyev et al., 2019), (Gomez, Ballard, et al., 2018)
13	Unwillingness to share profit	(Charlesraj & Gupta, 2019)

scenarios within IPD projects (Hunhevicz et al., 2022) further illustrates the potential of combining technological advancements with strategic management practices to address IPD adoption hurdles. Yet, this opens the door to questions about the readiness of the construction sector to embrace such complex, multidisciplinary solutions, in addition to the ongoing need for a paradigm shift towards a more collaborative, transparent, and efficient way of construction.

2.5.2 Framing the project

This theme pertained to the pre-construction phase and involved steps to establish project parameters, encompassing 18 publications across three categories: developing the contract (focusing on contractual topics), team selection (including papers on forming teams and procurement), and validation (addressing the validation phase).

Developing the contract

Several studies have analyzed and compared various collaborative IPD agreements and contract types, examining elements like dispute resolution, incentive measures, and change order processes, with findings emphasizing the influential role of interpersonal interactions over contractual terms (Marathe et al., 2017; Abd El-Moneim et al., 2017). Comparisons were also made between different forms, such as AIA C-191 and ConsensusDocs 300, in various aspects like risks, incentives, and dispute resolution (Ahmed et al., 2021). The first Canadian IPD agreement, CCDC30, was scrutinized for its language and definitions, suggesting room for improvement (Provost et al., 2022).

In addition, a contractual framework that combining the benefits of IPD and partnering contracts was developed and explored in the literature (El-adaway et al., 2017, 2018). Case studies on two distinct IPD contracts highlighted how alterations in contracting processes and types can influence relationships and pre-construction productivity (Mulholland & Clevenger, 2018). Studies have also explored the linkage between special purpose vehicle (SPV) procurement and IPD, deriving success criteria for stakeholder integration in SPV (Malaeb & Hamzeh, 2018), and inspected the regulatory and contractual dimensions of implementing IPD in public procurement processes in regions like Quebec (Jobidon et al., 2018). Lastly, the incorporation of IPD concepts into various delivery system contracts has been shown to offer numerous IPD benefits (Gomez, Naderpajouh, et al., 2018; Y. Zhang et al., 2019).

Team selection

A handful of studies have spotlighted the vital role of proper IPD team selection and identified critical skills for a project manager in collaborative construction projects, encompassing individual performance attributes like trustworthiness and stress tolerance, and team competencies like conflict management and understanding others (Guan, 2018, Moradi et al., 2021). Relational contracting norms, including shared vision and relational trust, have been underscored as important influencers of IPD team effectiveness (L. Zhang et al., 2020). The organizational structure of IPD, known for its flexibility, permits straightforward substitutions of project leaders and team members, accommodating corrective actions for misjudgments in team assembly (J. E. Laurent & Leicht, 2017). Moreover, the impact and benefits of utilizing an alternative technical concepts (ATC) procurement strategy within various project delivery systems have been examined, noting that the advantages of ATCs, which propose modifications to base design and construction criteria, are inherently assured by the IPD approach(Tian et al., 2020).

Validation

A limited number of studies have delved into project validation, an innovative strategy to design and examine project feasibility that introduces initial requirements as options and outlines design trade-offs and boundaries to enhance design decisions through exploring coinciding alternatives and interdisciplinary knowledge (Grau et al., 2021). Achieving a reliable cost estimate is pivotal during the IPD project validation stage, especially when project details remain unclear. Elghaish et al., (2020) introduced a BIM-enabled platform incorporating TVD, ABC, and Monte Carlo simulation into the IPD cost structure, exposing notable fluctuations in the profit-at-risk value across different project work packages. Furthermore, a case study, the Kingston Third Crossing Bridge project (Brownlie & Rajlic, 2019), demonstrates a successful validation process where collaborative efforts and innovative solutions, during a constrained timeline and significant affordability gap, enabled the team to redesign the project to align with allowable costs.

2.5.3 Setting the context

This theme, receiving minimal attention in the literature, focused on the phase subsequent to project framing, emphasizing setting the project and team on a successful path. The primary research centered on facilitating IPD by defining team roles, responsibilities, and establishing a decision-making structure.

Facilitation IPD

IPD introduces numerous innovations compared to traditional practices. Without enough education and training, there's a risk of reverting to old methods, highlighting the importance of proper IPD facilitation (Simonsen et al., 2019).

Roles and responsibilities

IPD projects are known for their effective, flexible, and decentralized governance structures, contrast with traditional top-down hierarchical models. Hall & Bonanomi, (2021) identified IPD as mirroring a common-pool resource scenario, necessitating crafted self-governance structures, especially given its shared risk-reward and collective decision-making attributes. However, stakeholder confidence during execution is influenced by numerous factors, and various control activities may be pivotal. While Frantz et al., (2021) found that control tasks can bolster trust without necessarily establishing a trust-control link, Manata et al., (2022) noted that a project manager's communication behaviors might hinder team function if teams already exhibit ample information sharing. Moreover, IPD can recalibrate project roles and responsibilities, influencing aspects like design development and coordination in architectural practice (Abdirad & Dossick, 2019).

Decision structure

Effective decision-making is influenced by well-structured organizations. A study of three network organizational structures—focal, dynamic, and multifocal—identified multifocal as the most successful for collaborative decision-making (Trach et al., 2021). Meanwhile, analysis of the Tønsberg project highlighted two challenging aspects of decision-making processes: the fact that large number of participants involved in decision-making due to a flat IPD organizational structure, leading to multiple discussion rounds; and the tendency to delegate the decisions to senior management frequently when resolutions were not achieved at lower levels (Kalsaas et al., 2020).

2.5.4 Executing the work

The project execution, covered in 28 papers, explored five aspects: the application of BIM in IPD, lean construction, prefabrication, the big room approach, and performance and challenges during implementation.

BIM

Literature frequently links BIM and IPD, indicating that IPD enhances BIM utilization and vice versa (Maskil-Leitan & Reychav, 2018; Trach et al., 2020; T. Wang & Feng, 2022; Rosayuru et al., 2022). This integration enhances communication, reduces construction duration, lowers costs, and boosts management efficiency (Salim & Mahjoob, 2020a; Wan & Yu, 2020). It can eliminate non-productive behaviors (Mei et al., 2017) and integrate heritage values into decision-making (Brahmi et al., 2022).

Various frameworks have been developed to integrate IPD and BIM, highlighting the need for specialized BIM platforms (Z. Ma & Ma, 2017) and leading to the creation of collaborative management models and information utilization frameworks (Y. Guo et al., 2017; Wei et al., 2021). These advancements have derived may attempts to explore and exploit the potential of IPD and BIM integration in different contexts and projects. Notably, a SWOT analysis was conducted on IPD-BIM integration in a Saudi Arabian project (Alwafi, 2022). A framework was also developed for integrating 4D BIM into IPD using activity-based costing (Elghaish & Abrishami, 2020a), and an integrated BIM, Lean, and IPD maturity model was introduced (Rashidian et al., 2022).

Building upon these innovations, researchers have continually sought to broaden the applications and optimize the strategies for BIM-IPD integration in various project contexts. For instance, B. Guo & Luo, (2020) employed an evolutionary game to examine control rights distribution in BIM-IPD projects, identifying several influencing factors on control right allocation mode. Similarly, Gao et al., (2020) developed a platform that integrates BIM and GIS to enhance project information flow in IPD projects. Moreover, a model that merges earned value management and activity-based costing was formulated to optimize cost structures in IPD and BIM projects (Elghaish et al., 2019). Hao et al., (2021) explored a BIM/VR-based communication system specifically for transportation infrastructure IPD projects. Lastly, barriers, including lack of interest and high costs, have been identified as significant impediments to BIM and IPD adoption in the UK construction industry (Dalui et al., 2021).

Lean

Research on integrating lean concepts and IPD, while limited, has identified notable benefits for collaboration in design, construction, and engineering management (Evans et al., 2021b; Evans et al., 2021c; Asl et al., 2022). Challenges include a lack of mandatory BIM and Lean Construction (LC) industry standards and insufficient government involvement (Evans et al., 2021a). A study on target value design, a pivotal lean technique in IPD, underscored the importance of market price, target cost settings, transparent shared profit agreements, and managing production costs for project delivery within the target cost (Tillmann et al., 2017).

Big room

The "big room," a strategy employed in IPD projects to enhance collaboration, provides a space for all team stakeholders to work collectively, often with visual documentation available (Allison et al., 2018). Among reviewed articles, only one research piece centered on the big room, with a virtual collaboration platform being developed to navigate challenges like the requisite high commitment and associated costs (Z. Ma et al., 2018).

Prefabrication

Although prefabrication is gaining interest as an economically viable alternative and environmentally friendly manufacturing approach, only one study in the specified timeframe explored its linkage with IPD. The study developed a conceptual framework for expanded producer responsibility in offshore prefabrication and identified IPD as an exceptional project delivery approach, enhancing communication, project performance, waste reduction, and sustainability (Xu et al., 2021).

Implementation performance and challenges

Research into IPD implementation challenges from the viewpoints of owners, builders, and designers in the U.S. and Canada highlighted three principal concerns: sustaining collaboration, managing IPD's operational nature, and team selection (Ebrahimi & Dowlatabadi, 2019a). Another study ranked "poor communication and spirit of collaboration between project stakeholders" as the top challenge among 30 identified in IPD implementation, due to IPD's reliance on stakeholder collaboration and trust (Othman & Youssef, 2020). Moreover, key performance indicators for enhancing infrastructure project performance via an IPD and BIM model were found to include BIM's facilitation of real-time data access, data interoperability and compatibility, and the minimization of claims and disputes (Bapat et al., 2021).

2.5.5 Optimizing excellence

The theme of optimizing excellence in IPD projects emphasizes enhancing efficiency and effectiveness through collaboration, integration, team alignment, and risk management, as covered in 34 assessed publications. Collaboration was especially highlighted, being the focus of 21 publications.

Collaboration

Project management has evolved significantly with the adoption of the IPD model, which emphasizes collaboration, enhanced by trust among team members and BIM technology support (Pan & Rao, 2021). Recognized as a key feature of IPD, collaboration is shown to be directly related to improved project performance (Hamzeh et al., 2019; P. J. Barutha et al., 2021; Mei et al., 2022). The information sharing in IPD projects benefits various team- and project-level outcomes (Manata et al., 2022). Many studies have explored collaboration, primarily from two main perspectives: its triggers and its role within contracts and project delivery systems.

Collaboration triggers: Effective collaboration in IPD projects hinges on several factors, with trust, particularly goodwill and competence, alongside formal contracts, being foundational (L. Zhang, Huang, et al., 2018). This collaboration is further influenced by individual and team capacities, especially in applying transferred knowledge and maintaining dynamic capabilities and trust-based communication (Joseph Garcia & Mollaoglu, 2020; L. Zhang et al., 2017). Moreover, leadership aspects, encompassing various styles and emotional intelligence, directly impact multiple collaboration satisfaction outcomes (L. Zhang, Cao, et al., 2018).

IPD, while enhancing short-term socio-technical process collaboration, encounters hurdles in developing long-term partnerships (Tvedt, 2019). Notably, early contractor involvement, owner's initial goals, and strategic communication behaviors are vital to bolstering positive collaboration (Malvik et al., 2021; Liu et al., 2021; Manata et al., 2018).

Further, strategies in knowledge-sharing and interaction behavior significantly mold project performance and collaboration (Yanchao Du et al., 2019), with the embedding of a collaborative culture ideally commencing with dedicated education and training (Martin, 2020). Finally, while the triggers for collaboration were studied, the obstacles to collaboration, specifically challenges to collaborative planning in the construction sector, were also analyzed and found to include 50 different challenges (Elsayegh & El-adaway, 2021).

Collaboration within contracts and project delivery systems: Several studies have explored collaboration within various contract types. While IPD contracts were found to have a higher prevalence of collaboration-related phrases and practices, traditional contracts predominantly focused on compliance (Alves & Shah, 2018a; Willis & da Alves, 2019). J. Cheng et al., (2022) identified a significant indirect impact of trust and relational norms on collaboration. Interestingly, a study found minimal differences in collaboration and integration dimensions between traditional and IPD methods, indicating potential for collaboration in both approaches (Koolwijk et al., 2018). Additionally, M. L. Viana et al., (2022) introduced a framework to determine IPD collaboration levels, utilizing a percentage ratio and mathematical weight calculation for classification and identification purposes.

Integration

Integration in IPD projects was approached from two perspectives: its advantages and the development of integrated teams. Research has shown that integration positively influences project performance, enhancing control over schedule growth (Franz et al., 2017) and significantly impacting project management via the integration of knowledge, processes, staff, and the supply chain (Demirkesen & Ozorhon, 2017). It also enhances constructability review during design but presents challenges like ensuring effective stakeholder participation (Padala & Maheswari, 2017).

Shifting the lens towards developing integrated teams, the emphasis was laid on the crucial role of establishing multidisciplinary teams early in the design phase (J. Laurent & Leicht, 2019) and exploring the influence of contracts and cultural elements on team development (Engebø et al., 2020). In the context IPD's project-based setting, integration mechanisms have emerged as multifaceted entities, enveloping a range of organizational and operational elements (Rankohi et al., 2022). Moreover, investigating the relationship between IPD and Special Purpose Vehicle (SPV) motivated the development of a methodology designed to enhance SPV stakeholder integration (Malaeb & Hamzeh, 2021). Concurrently, maintaining existing organizational structures was found to effectively manage complexity and achieve integration (Rajakallio et al., 2017).

Team alignment

Two papers highlighted the significance of team alignment in IPD projects. Agbaxode et al., (2020) found that principles such as early engagement and collaboration are crucial for promoting the common good of the project and stakeholders, while Manata et al., (2020) identified that team member commitment is pivotal to reaping IPD benefits and preventing potential challenges.

Risk management

Risk management in IPD projects is a crucial part of maintaining project excellence. Research has found that organizational procedures, operating systems, and early planning are key for risk management in IPD projects (Lan et al., 2017). Measures for improving project performance and mitigating risk escalation were developed in Su et al., (2021). They suggested that risk-sharing techniques in IPD projects should take into account four levels: risks for project objective achievement, risks in the project management process, the incentive mechanism, and influencing variables.

While IPD is designed to enhance project value, its implementation can be challenging and potentially introduce new risks, particularly if team members lack commitment. Research scrutinizes the substantial threats in high-stakes IPD projects, such as poor integration quality within multidisciplinary teams and inaccurate target costs and estimates, exploring how these may be mitigated through past and future collaborations among IPD partners (Q. Ma, Li, & Cheung, 2022).

2.5.6 Reaping the benefits

This theme, discussed in 37 studies during the reviewed period, emphasized the outcomes of successful IPD projects, primarily focusing on two core topics: profits and payouts and the benefits of IPD, clarifying the comprehensive potential that IPD can introduce to construction projects.

Profits and payout

Several papers have focused on profit distribution and payout mechanisms in IPD projects. Researchers have sought to develop balanced profit distribution schemes among project stakeholders, based on their contributions and share of risks (S. Guo et al., 2021; S. Guo & Wang, 2021; Teng et al., 2017; Yue Teng et al., 2019; S. Guo & Wang, 2022), and to optimize profit distribution in an IPD project by determining and implementing the optimal level of effort from each participant (S. Guo et al., 2022). Incentive compensation systems have also been proposed to improve cost management (Q. Wang et al., 2019) and reduce change orders (J. Ma et al., 2017).

An IPD cost management system has been designed to facilitate the IPD cost structure and automate risk-reward sharing formulas (Elghaish & Abrishami, 2020b). A cash flow methodology framework has been developed to optimize cash flow management in IPD projects using 4D and 5D BIM (Elghaish et al., 2021). However, when project costs exceed target costs, contingency, and at-risk profit, not all IPD contracts and practices effectively maintain team collaboration (Pishdad-Bozorgi & Srivastava, 2018).

Benefits of IPD

The benefits of IPD, explored across 26 papers, consistently point to a wide range of advantages, as detailed in **Table 2.5**. Notably, research generally favors IPD over other delivery systems for its potential to enhance project productivity, quality, and satisfaction (H. Ashcraft, 2022b). Among the highlighted benefits, IPD can notably reduce overall project duration, scheduled growth, and change order processing time, while also minimizing decision-making time (Adamtey, 2021; M. Ibrahim et al., 2018, 2020; Phuong Nguyen & Akhavian, 2019; Y. Zhang & Hu, 2018, 2020; Shadhar et al., 2022; Adel et al., 2022; Shane et al., 2020). From a financial perspective, IPD not only lowers overall project costs and cost growth factors but also provides enhanced value for money and demands less investment (Adamtey, 2021; Andary et al., 2019; M. W. Ibrahim et al., 2018, 2020; Trach et al., 2019;Salim & Mahjoob, 2020b; Shane et al., 2020).

Quality improvements, including the reduction of deficiencies, punch-list items, and early detection of design clashes, alongside enhancing buildability and overall project system quality, are also associated with IPD use, as supported by several studies (M. W. Ibrahim et al., 2018, 2020; Salim & Mahjoob, 2020b; Adamtey, 2021; Y. Zhang & Hu, 2018, 2020).

IPD notably excelled in enhancing the work environment, fostering a heightened sense of ownership among team members and bracing team integration and collaboration, including an

Table 2.5 Benefits of IPD

#	IPD Benefits	References
1	**Time**	
1.1	Reduce the total duration of the project	(Phuong Nguyen & Akhavian, 2019) (Y. Zhang & Hu, 2018, 2020), (Shadhar et al., 2022), (Adel et al., 2022)
1.2	Less schedule growth	(M. W. Ibrahim et al., 2018, 2020) (Adamtey, 2021)
1.3	Reduce decision-making time	(Shane et al., 2020)
1.4	Reduce change order processing time	(M. W. Ibrahim et al., 2018, 2020)
2	**Cost**	
2.1	Less cost growth	(M. W. Ibrahim et al., 2018, 2020) (Adamtey, 2021)
2.2	low pursuit cost	(Shane et al., 2020)
2.3	Reduces the total cost	(Adamtey, 2021) (Trach et al., 2019) (Andary et al., 2019), (Shadhar et al., 2022), (Adel et al., 2022)
2.4	Achieve better value for money	(Salim & Mahjoob, 2020)
3	**Quality**	
3.1	Reduce number of deficiency issues	(M. W. Ibrahim et al., 2018, 2020)
3.2	Reduce number punch-list items	(M. W. Ibrahim et al., 2018, 2020)
3.3	Increase overall project systems quality	(M. W. Ibrahim et al., 2018, 2020) (Salim & Mahjoob, 2020)
3.4	Early detection of clashes	(Salim & Mahjoob, 2020)
3.5	Improve the buildability of the design	(Rodrigues & Lindhard, 2021)
4	**Change Management**	
4.1	Reduce design related change	(M. W. Ibrahim et al., 2018, 2020)
4.2	Reduce quality/value-related change	(M. W. Ibrahim et al., 2018, 2020)
4.3	Reduce project overall change	(M. W. Ibrahim et al., 2018, 2020) (Adamtey, 2021) (Y. Zhang & Hu, 2018, 2020)
5	**Work Environment**	
5.1	Higher team integration and collaboration	(Choi et al., 2019) (Adamtey, 2021) (Bilge, 2020) (Rodrigues & Lindhard, 2021)
5.2	Improve the owner-contractor relationship	(Yang & Deng, 2018)
5.3	Foster strong relationships between team	(Shane et al., 2020)
5.4	Employee-pleasant working conditions	(Shane et al., 2020)
5.5	Enable fiscal transparency which fosters trust	(Shane et al., 2020)
5.6	Increase ownership among project members	(Rodrigues & Lindhard, 2021)
5.7	Reducing the waste in the construction phase	(Salim & Mahjoob, 2020)
6	**Risk**	
6.1	Reduces Risk	(Chen et al., 2020) (El-Said et al., 2019) (Barutha et al., 2018) (Rodrigues & Lindhard, 2021)
6.2	Better owner risk control	(Shane et al., 2020)
7	**Workflow**	
7.1	Reduce number of RFI	(M. W. Ibrahim et al., 2018, 2020) (Salim & Mahjoob, 2020)
7.2	Reduce RFI processing time	(M. W. Ibrahim et al., 2018, 2020) (Andary et al., 2019)
7.3	Increase the productivity of the project	(Salim & Mahjoob, 2020)
7.4	Facilitate constructability	(Jadidoleslami et al., 2022)
8	**Overall Satisfaction**	
8.1	A more satisfied owner	(Choi et al., 2019), (Barrows & Grosskopf, 2022)
8.2	Improve the overall performance of the project	(Abi Shdid et al., 2019) (Tang et al., 2019) (Barutha et al., 2018) (Y. Zhang & Hu, 2018, 2020) (Ling et al., 2020)

improved owner-contractor relationship (Rodrigues & Lindhard, 2021; Adamtey, 2021; Choi et al., 2019; Rodrigues & Lindhard, 2021; Yang & Deng, 2018). This enhanced stakeholder collaboration, key for the efficient implementation of innovative financial models like the real estate certificate, also facilitated the establishment of strong team bonds and employee-friendly conditions, promoting trust through fiscal transparency (Bilge, 2020; Shane et al., 2020). Furthermore, IPD has demonstrated its capability to create an efficient work environment, reducing waste during construction phases (Salim & Mahjoob, 2020b; Jadidoleslami et al., 2022).

Regarding risk, IPD has been proven to mitigate uncertainties about project outcomes and to involve owners thoroughly in project processes, thereby refining risk management. Additionally, it exposes participants to lesser risk compared to traditional delivery methods (P. Barutha et al., 2018; Rodrigues & Lindhard, 2021; Shane et al., 2020; Chen et al., 2020; El-Said et al., 2019).

The final observed IPD benefits pertain to workflow and overall satisfaction. Research highlighted IPD's ability to decrease the number of RFIs and their processing time, and enhance project productivity levels (Andary et al., 2019; M. W. Ibrahim et al., 2020; Salim & Mahjoob, 2020b). In terms of the overall satisfaction, IPD projects saw more satisfied owners with ability to boost overall project performance (Choi et al., 2019; Barrows & Grosskopf, 2022; Abi Shdid et al., 2019; Ling et al., 2020; P. Barutha et al., 2018; Tang et al., 2019; Y. Zhang & Hu, 2018, 2020).

Conversely, not all studies on IPD performance shared the same optimism. Kelly & Ilozor, (2022) found no significant performance outcomes at a 95% confidence level for IPD projects, and suggested owners temper their expectations regarding IPD’s capability to address numerous industry issues, despite observing less schedule and cost growth.

2.6 Discussion

The findings from the R&D framework development process indicate a growing trend in IPD research over the past six years, confirming previous reports by (Kahvandi et al., 2017; Viana et al., 2020; Rashed & Mutis, 2021; Rankohi et al., 2022b). This study nuances its approach by developing a dedicated R&D framework for IPD, providing a navigation tool through recent literature and providing the mechanisms needed for a structured and consistent R&D approach to IPD. Historically, the domain has been driven by industry practices, with academia striving to keep pace. This trend is reflected in the predominance of practical frameworks within IPD, highlighting a gap between theoretical research and practical application. The proposed R&D framework aims to bridge this divide by providing a systematic structure for academic research to contribute more effectively to the field. Designed to map existing IPD research and identify under-researched areas, it aligns with industry phases and steps, fostering greater collaboration between industry and academia. Thus, the framework acts as a catalyst for advancing IPD research and development, ensuring academic efforts align with industry needs and contribute to a comprehensive understanding and implementation of IPD.

Established frameworks such as (Guide, A.I.A, 2007; Cheng & Johnson, 2016; Allison et al., 2018) were adopted during the development process. They served as a foundation for the themes and categories that formed the preliminary framework. These were systematically combined with the codes from the thematic analysis of selected papers and enriched by insights from three case studies and a panel of experts. This study expanded on these frameworks by linking IPD implementation elements with IPD-focused research, resulting in a three-layer R&D framework (themes, categories, and codes). This extension makes the IPD R&D framework a useful navigation tool for industry professionals seeking knowledge related to specific IPD areas, enhancing its practical application.

One key contribution of this study is identifying several knowledge gaps in IPD. This is evident in two ways. Firstly, it highlights less-represented categories within IPD, signaling emerging or insufficiently researched areas. Including these categories in the R&D framework underscores their importance as under-researched areas needing further study, regardless of the current limited number of studies. Secondly, through the analysis of three case studies, this study identifies topics and issues not yet explored in existing research, underscoring the need for further investigation to advance the field of IPD.

The R&D framework serves as a lens through which the evolving landscape of IPD research is viewed, revealing well-explored paths and areas ripe for further examination. The review highlights a strong emphasis on topics such as collaboration, integration with BIM, and the benefits of IPD, alongside persistent adoption barriers. It also highlights underexplored areas such as roles and responsibilities, decision structure, facilitation, work environment, integration with Lean, team alignment, and team culture, as well as a lack of focus at the organizational level. A closer examination of current research within each theme and category reveals nuanced gaps, setting the stage for targeted future inquiries.

Choosing IPD: Choosing IPD has attracted considerable attention, with extensive studies on its driving factors and adoption barriers. Although well-explored at the project level, a distinct need remains to explore these factors at the organizational level. Future research should focus on organizational change management and the necessary adjustments for adopting a collaborative business model, such as IPD, more broadly within AEC organizations. Moreover, the complexity of solutions proposed to overcome the barriers raises questions about the construction sector's readiness for such complex approaches.

Framing the Project: This theme addresses crucial pre-construction aspects. Many studies have examined how contractual arrangements influence outcomes, suggesting a mature yet evolving understanding of these frameworks' roles. Future research could focus on optimizing these frameworks for varying project types and regulatory contexts.

Research on "Team Selection" has detailed the essential attributes for effective collaboration in IPD settings, demonstrating a well-established grasp of team dynamics. However, the team selection strategies and procedures point to potential areas for deeper investigation. Similarly, "Validation" represents a less studied but critical phase, as evident by the case studies, where project feasibility and design decisions are assessed. This area indicates a gap in comprehensive understanding and application, with few details on its mechanisms, strategies, and best practices.

Setting the Context: This theme is crucial for establishing robust roles and governance frameworks but has received limited research attention. Research on IPD facilitation is sparse despite its critical role, as shown by three case studies where training and education were essential to maximize IPD benefits. Thus, a comprehensive exploration of facilitation strategies in IPD projects offers a promising avenue for discoveries.

Studies on Roles and Responsibilities have highlighted IPD's unique governance structures, yet unexplored areas remain. These include IPD's influence on common roles and responsibilities within the AEC sector, its impact on effectiveness, and participant perceptions.

Decision Structure is crucial for effective IPD project management but represents one of the less investigated areas. The complexities of maintaining efficient decision-making in IPD's flat structures require deeper analysis. Future research should focus on developing an inclusive yet efficient decision-making process (i.e., the thresholds at which adding more parties to decision-making becomes less effective or more costly) to optimize decision-making in IPD projects.

Executing the Work: Many studies have addressed this theme, yet several underexplored areas offer clear pathways for future research. This is mainly due to overemphasizing BIM integration over other aspects essential to IPD execution, such as Lean integration. This imbalance underscores the need for further investigation into Lean construction and design principles within the IPD framework.

The Big Room approach, a significant catalyst for collaboration as evidenced by three case studies, has seen limited research focus. Its effectiveness, advantages, disadvantages, and management strategies require comprehensive study.

Although IPD is increasingly recognized as a facilitator for innovative practices like prefabrication, DfMA, and other sustainable techniques, research on the link between IPD and these practices is scarce. This area needs immediate attention to explore how IPD's collaborative environment could promote broader adoption of innovative practices in an industry that often struggles with such adaptation.

Research on IPD implementation challenges has received considerable attention, focusing on challenges around sustaining collaboration, managing complexity, and fostering trust. These challenges often overlap with barriers to IPD adoption, blurring the lines between implementation difficulties and adoption obstacles. More targeted research is necessary, especially as implementation conditions vary across different markets, regulatory environments, and project types. Additional case studies in diverse settings are essential to deepen understanding and enhance the IPD field.

Optimizing Excellence: This theme encompasses efforts to enhance efficiency and effectiveness in IPD projects, highlighting the pivotal role of collaboration, integration, team alignment, and risk management. While collaboration is extensively addressed, many studies assume collaboration in IPD projects is a given. However, to truly optimize excellence, there is a need to understand the roadmap, specific measures, and contributors within IPD projects that facilitate effective collaboration.

Integration has been explored primarily for its benefits and the establishment of integrated teams within IPD projects. Given the central role of integration within IPD, there is substantial scope for examining how integration strategies enhance stakeholder engagement and project value under different regulatory and market conditions.

Though minimally covered in literature, team alignment receives considerable emphasis in case studies, stressing the alignment of team goals and values. This opens significant avenues for researching mechanisms to ensure alignment, understanding contributing factors, and distinguishing it from other project delivery methods. Furthermore, delving into team alignment might lead to broader inquiries into team culture, a critical yet another underexplored aspect within IPD. Investigating how team culture is developed and maintained and its impact on IPD outcomes are essential areas for future studies.

Jointly managing and sharing risk is a fundamental principle of IPD, widely mentioned in IPD literature. However, studies explicitly addressing risk management typically focus on identifying sources of risk, particularly challenges related to team commitment, integration quality among multidisciplinary teams, and inaccurate target costs and estimates. Future research could more deeply investigate risk ownership and mitigation strategies, differentiating them from those in other project delivery frameworks.

Reaping the Benefits: This theme has received considerable attention in the literature, focusing on the benefits of IPD and profit and payout mechanisms. However, this review underscores the need for concrete data on performance metrics like budgets, schedules, change orders, and disputes. Therefore, additional case studies are essential to provide quantitative evidence of IPD's efficiency.

Comparing these findings with previous IPD research trends before 2017, it is evident that significant progress has been made in understanding various aspects of IPD. However, much work remains to fully optimize this approach. The IPD R&D framework presented in this study serves as a useful tool for future research, facilitating a more holistic understanding of IPD.

2.7 Conclusion

This study navigated the various aspects of IPD, both implementation and research. It proposed an IPD R&D framework informed by insights from the established frameworks, a systematic literature review, and validation insights drawn from three case studies and a panel of experts. This framework could enhance our understanding of the IPD and guide it toward fresh avenues of research and practice.

The study concludes that over the last six years, 2017-2022, there has been a rise in the number of studies investigating IPD, reflecting an increasing trend in IPD research. In addition, it concludes that IPD is a promising field of study that shows a potential to address the construction industry's many challenges through a set of drivers for success and a wide range of benefits gained from its collaborative and integrative approach. Furthermore, this study revealed that many aspects of the IPD processes and strategies have yet to be sufficiently investigated, and therefore, much work remains to fully optimize this approach.

Throughout this research, insights have been obtained in addressing the research questions set forth. Regarding the first research question, which aimed to understand the current state of research and development in IPD, a systematic literature review was undertaken. This review mapped the landscape of IPD research and pointed to key themes and trends. About the second research question, which focused on capturing and categorizing the constituent parts of IPD, an IPD R&D framework was developed. This framework, informed by established IPD frameworks and findings from the systematic review, organizes IPD research into coherent themes, uncovering well-explored and under-researched areas. It aids in enhancing research accessibility and analysis within the field. The third research question, concerning the identification of mechanisms and approaches necessary for a structured approach to IPD R&D, was addressed through the development of the R&D framework, which functions as a guide, organizing existing knowledge and outlining directions for future research.

This research is underpinned by practical motivations within the field, emphasizing practical aspects over theoretical contributions in line with the pragmatic approach that anchors this investigation. The rationale behind this focus stems from the belief that the true value of theoretical insights lies in their applicability and impact on practice. The intent of this focus is to support a structured investigation into IPD R&D by bridging the divide between theoretical research and practical application and providing a systematic structure for academic research to contribute more effectively. Acknowledging that this practical orientation may limit the scope of theoretical exploration, this study aimed to provide structured insights into IPD implementation rather than broad theoretical differentiation. Recognizing this as a potential limitation, future research is encouraged to explore more profound theoretical distinctions between IPD and other project delivery methods, potentially enriching both the academic and practical understanding of IPD.

This study's review scope was restricted to peer-reviewed journals and conference papers. Other forms of references, such as books and dissertations, were not included in this study. This choice was made with the intention of keeping the number of chosen articles manageable in terms of the size of the research team and the timeframe available for the study. Indeed, there is much interesting grey literature in the field of IPD, such as industry reports and blogs that include rich information and experience from IPD-related projects and practitioners. Although these sorts of references were not included in the systematic review, some of the most important efforts were cited and built upon in various locations throughout the paper.

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CHAPTER 3

A CAPABILITY MATURITY MODEL FOR INTEGRATED PROJECT DELIVERY

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3.1 Abstract

As the adoption of Integrated Project Delivery (IPD) progresses, increasing evidence highlights its potential to improve project outcomes. However, as an emerging practice, there remains a lack of structured mechanisms to evaluate the maturity of its implementation, which can limit opportunities for learning and improvement. Therefore, this study introduces an IPD Capability Maturity Model (IPDCMM) to evaluate the maturity of IPD implementation at the project level. This model enables organizations to benchmark their IPD capabilities against established best practices, facilitating structured development and continuous improvement. This model is designed as a post-project assessment tool that evaluates the maturity of IPD practice upon project completion, providing critical insights for learning and future project enhancements. The methodology, underpinned by a pragmatic philosophy and guided by the principles of Design Science Research (DSR), prioritizes achieving practical outcomes (artifact). It combines insights from IPD frameworks, maturity models from other fields, and three case studies. The IPDCMM was developed alongside the IPD Maturity Assessment Tool (IPD-MAT), an artifact validated via evaluation sessions and feedback interviews with key stakeholders of IPD case studies. This model provides a structured framework for assessing

IPD implementation maturity and facilitates a pathway for enhancing IPD practices and achieving efficiency in project delivery.

Keywords: integrated project delivery, IPD capabilities, IPD Maturity Model, IPD assessment tool.

3.2 Introduction:

Integrated Project Delivery (IPD), defined by the American Institute of Architects (Guide, 2007) as a project delivery approach that integrates people, systems, business structures, and practices into a collaborative process aimed at optimizing project outcomes and improving efficiency. The conceptualization of this approach extends beyond contractual and operational definitions, framing IPD as the integration of solution development and solution implementation across project phases, with a strong emphasis on early collaboration and shared goals among stakeholders (Mihic et al., 2014), contributing to its growing popularity as a collaborative approach to project delivery (Rashed & Mutis, 2023). This is evidenced by an increasing number of cases which have demonstrated its effectiveness over traditional project delivery systems, speaking to its transformative approach within the construction industry (Ibrahim et al., 2020). These documented cases exhibit a wide range of maturity levels in their implementation, highlighting variability and potential for improvements in its application (Cheng & Johnson, 2016; Poirier et al., 2022). In other domains, maturity models were utilized to enable organizations to benchmark their practices against industry best practices and, therefore, structure their development. However, the absence of mechanisms specifically tailored to evaluate the performance of IPD deployment constrains the ability to fully understand and systematically evaluate its implementation (Rashidian et al., 2022).

The evolution of capability-maturity models across diverse disciplines illustrates their critical role in enabling organizations to benchmark their practices against industry best practices, identify areas for improvement, and strategically advance their capabilities (Succar, 2010). Maturity levels allow distinction between immature and mature entities, processes, and operations, allowing for a precise evaluation and clear path for progression (Sarshar et al., 2000). Originating in the software engineering domains, these models have proven instrumental in diverse fields, such as IT and information systems management, supply chain, human resources, and organizational development. Similarly, in construction-related disciplines like project management, Lean, and Building Information Modeling (BIM), maturity models have served to outline clear pathways for the adoption and development of these methodologies (Wendler, 2012).

Existing capability-maturity models from closely related fields to IPD, such as project management, supply chain management, BIM, and Lean, offer a valuable foundation, providing insights beneficial for IPD assessments (Rashidian et al., 2022). Yet, these models fall short of addressing the unique aspects of the IPD approach, such as its distinct processes, implementation phases, and the specific capabilities necessary for effective execution. There is therefore a notable gap in available models to precisely gauge and guide the adoption and implementation of IPD. Developing a dedicated maturity model for IPD appears as an important step in its development as a collaborative project delivery method with the potential to overcome many of the construction industry's shortcomings.

The study aims to address this gap by developing a capability maturity model for IPD to enable assessment at the project level. The proposed IPD Capability Maturity Model (IPDCMM) is specifically designed to support projects and organizations in benchmarking their IPD practices against established best practices, structuring their development, and facilitating ongoing improvement. Critically, the primary focus of this study is to utilize the IPDCMM to assess the maturity of IPD practice at the conclusion of a project. By concentrating on the post-project review phase, this paper highlights the utility of the IPDCMM as a post-project assessment tool, enabling informed evaluations that are pivotal for deriving lessons learned and continuous improvement of IPD implementation.

This emphasis on post-project assessment was influenced by both practical and strategic considerations. The case studies used in the model development were completed projects, naturally lending themselves to retrospective analysis. In addition, the post-project phase offers a valuable opportunity to evaluate practices, learn from lessons, and facilitate continuous improvement. While this paper prioritizes post-project assessment, the model's potential use during planning and implementation phases is acknowledged and forms part of ongoing research. On a related note, although the model is initially applied at the project level, its implications extend to organizational learning as well. It facilitates the transfer of successful practices and lessons learned from one project to another, thereby progressively enhancing overall organizational proficiency in IPD.

To achieve the main objective and develop the IPDCMM, five elements (sub objectives) were addressed:

- **Defining IPD Maturity Levels**: Establishing distinct maturity levels within IPD practices and providing clear criteria for progressing through these levels.
- **Identifying IPD Capabilities**: Undertaking a detailed examination, identification, and categorization of specific capabilities essential for successful IPD implementation.
- **Identifying IPD Capability Indicators**: Identifying indicators of capabilities derived directly from practical applications of IPD.
- **Developing the IPD Maturity Matrix**: Integrating IPD Capabilities and IPD Maturity Levels to form a detailed maturity matrix that outlines the indicators of each capability within each maturity level.
- **IPD Maturity Assessment Tool**: Transforming the detailed maturity matrix into a tool that enables evaluation and determines the maturity level of different capabilities.

The methodology employed in this study, underpinned by a pragmatic philosophy and guided by the Design Science Research (DSR) methodological approach, was designed to prioritize achieving practical outcomes in the form of artifacts that can be beneficial in improving IPD implementation. This approach aligns with established methodological frameworks for creating maturity models, specifically those detailed by (Becker et al., 2009) and (De Bruin et al., 2005). The process combined insights from existing IPD frameworks, maturity models, and three case studies. Through staged development, the IPD Maturity Model was created, leading to the creation of the IPD Maturity Assessment Tool, which was validated via evaluation sessions and feedback interviews with key stakeholders of IPD case studies.

The paper begins by exploring established maturity models from other domains and the foundational IPD frameworks in the background section. A detailed methodology section follows, outlining the processes and validation techniques employed. Subsequent sections present the results, including the Maturity Levels, the IPD Capabilities, the Capabilities Indicators, the IPD Maturity Matrix, and the IPD Maturity Assessment Tool, before moving to the discussion and conclusion, which discuss the results and highlight the implications of the research in the field.

3.3 Background:

3.3.1 Established Maturity Models

The Materials Maturity models have been widely used across different fields to measure organizational and process maturity, supporting entities in progressing from ad-hoc toward optimized practices. Though maturity models are very common in fields like Human Resources, IT, Construction Process, Project Management, Supply Chain, BIM, Lean, and Digital Transformation, their adaptation to the IPD domain presents unique challenges due to the uniqueness in processes and capabilities of IPD. Nonetheless, they still provide valuable insights for creating a maturity model specifically tailored to the requirements of IPD (Rashidian et al., 2023).

Maturity models in domains such as IT, human resources, and construction use structured frameworks to measure capabilities and readiness. Examples include the People Capability Maturity Model for human resources (Curtis et al., 2009), COBIT for IT (Lainhart IV, 2000), and the SPICE for construction processes (Sarshar et al., 2000) as examples of ways in which such frameworks facilitate informed evaluation and enhancement in asset management, risk management, and process optimization maturity. Additionally, the LESAT model in Lean (Initiative, 2001), the PM2 in project management (Kwak & Ibbs, 2002), and the SCM in supply chain management (Lockamy & McCormack, 2004) assess and refine the integration of principles and practices within organizational operations.

In the field of Building Information Modeling (BIM), the development of models like the BIM Maturity Matrix (BIMMM) (Succar, 2010), the NBIMS CMM Maturity Model (Sciences (NIBS), 2007), as well as the Indiana University's BIM Proficiency Matrix (Standards, n.d.), emphasizes assessing the capabilities of BIM and driving improvement in implementation and adoption within the construction industry. These models deal with different aspects, ranging from selecting the team to measuring performance.

Despite the broad application of maturity models across various domains, only a few studies have touched, although indirectly, on IPD maturity through integrating IPD with BIM and Lean. For instance, one study proposes a preliminary framework for evaluating organizational productivity through the combined application of BIM, IPD, and Lean Construction (LC), highlighting capabilities such as strategic problem-solving, collaborative governance, and enhanced decision-making capabilities. Another study has introduced the BIM, IPD, and Lean Integration Maturity Model (BILMM) to identify critical maturity attributes for BIM, IPD, and LC integration, emphasizing the importance of communication skills, process optimization, and the facilitation of continuous improvement (Rashidian et al., 2023). This cross-domain synthesis underlines a significant gap in maturity models explicitly tailored for IPD that distinctly address its unique processes and capabilities. This study aims to bridge the gap by introducing a maturity model designed explicitly for IPD processes and capabilities.

3.3.2 Established IPD Frameworks

Given the lack of prior studies developing a maturity model for IPD, this review concentrated on existing IPD frameworks. Although few, they offer a comprehensive overview and detailed insights into IPD’s elements, components, and capabilities. They aid in developing a holistic understanding of IPD by deconstructing its complex structure into categorizable components aligned with distinct phases and capabilities necessary for effective adoption and implementation, as detailed in **Table 3.1.**

Table 3.1 Established IPD Frameworks

#	Framework/Study Title	Citation	IPD Framework Components
1	Integrated Project Delivery: A Guide	AIA, 2007	Phases: Conceptualization, Criteria design, Detailed design, Implementation documents, Agency review, Buyout, Construction, Closeout.
2	Integrated Project Delivery: An Action Guide for Leaders	Allison et al., 2018	Project structuring, Team composition, Decision-making process, Communication, Risk mitigation, Performance evaluation.
3	Motivation and Means: How and Why IPD and Lean Lead to Success	Cheng & Johnson, 2016	Context, Legal/Commercial, Leadership/Management, Processes/Lean, Alignment/Goals, Building Outcomes.
4	Investigating Factors Leading to IPD Project Success in Canada	Poirier et al., 2022	Making the Case for IPD, Framing the Project, Choosing the Team, Setting the Context, Executing the Work, Maintaining Excellence, Reaping the Benefits.
5	A research and development framework for integrated project delivery	Arar et al., 2024	Choosing IPD, Framing the project, Setting the context, Executing the work, Optimizing excellence, Reaping the benefits.
6	IPD in Norway	Aslesen et al., 2018	Contract, Technology and Processes, Culture.
7	Integrating Project Delivery / The Simple Framework	Fischer et al., 2017	Integrated information, Integrated organization, Integrated processes, Integrated building systems.
8	The IPD Framework	Ashcraft, 2012	Macro-Framework: Contract terms, Business configuration; Micro-Framework: Operational protocols, Work design, Information design, Team formation.

One foundational guide in this field is the American Institute of Architecture's "Integrated Project Delivery: A Guide," which segments IPD into eight phases: conceptualization, criteria design, detailed design, implementation documents, agency review, buyout, construction, and closeout. Each phase focuses on specific capabilities and collaborative practices essential for IPD's successful execution (Guide, 2007). Similarly, the framework by (Allison et al., 2018) serves as a practical blueprint for IPD, offering a detailed perspective for top management and emphasizing aspects like project organization, communication strategies, risk management, and performance metrics. It underscores the importance of strategic capability, including team formation and decision-making processes, crucial for effective IPD implementation.

Other frameworks have also provided detailed categorizations of IPD elements and capabilities. (Cheng & Johnson, 2016) introduced 'markers' to categorize IPD elements into context, legal/commercial, and leadership/management, which were developed from extensive workshops with North American industry experts. (Poirier et al., 2022) refined these into stages, such as Making the Case for IPD, Framing the Project, and Executing the Work, to align closely with IPD implementation. Additionally, an R&D framework for IPD, developed in the preceding step of this research project, aims to create more targeted and effective progress in academia and practice. This framework outlines six primary themes—Choosing IPD, Framing the Project, Setting the Context, Executing the Work, Optimizing Excellence, Reaping the Benefits—organized into 19 categories to support structured IPD research and development (Arar et al., 2024).

Furthermore, (Aslesen et al., 2018) categorize IPD into contract, technology and processes, and culture, emphasizing the necessity of collaboration and integration at each stage. (Fischer et al., 2017) introduce "The Simple Framework" in their book "Integrating Project Delivery," which integrates organization, processes, information, and systems to streamline IPD practices. This framework specifically addresses contracting and traditional contract issues while detailing high-performing buildings, collaboration, co-location, metrics, and leadership in IPD, offering a detailed view crucial for developing IPD capabilities. (Ashcraft, 2012) proposes a dual framework: the macro-framework focuses on overarching contract terms and business configurations, while the micro-framework delves into operational protocols such as work design, information design, and team formation strategies. These elements together provide a detailed overview of the operational elements critical for IPD success.

These existing frameworks provide an overview of IPD's diverse elements, showcasing theoretical foundations and practical applications. Although they provide useful insights, they do not clearly define a process or method for evaluating IPD practices or determining implementation maturity. Their primary focus has been on bringing together the different components of IPD, constructing its overarching framework, and identifying critical success factors for this approach, rather than defining the specific capabilities required for successful IPD implementation. Therefore, a review of these frameworks reveals a clear gap in the characterization of IPD capabilities and the absence of a structured framework and mechanisms for assessing and advancing IPD implementation. This lack underscores the necessity for a maturity model specifically tailored to IPD that assesses its practices and outlines a clear progression path to refine and advance IPD capabilities. This study aims to fill this gap by introducing a capability-maturity model at the project level that builds on these established frameworks, as detailed in Sections 3.2 and 4.2. This model provides a systematic approach to the assessment and continuous improvement of IPD practices at the project level, which allows for refining practices that directly influence the success of IPD implementation and enhances its adoption.

3.4 Methodology

The methodology for developing the IPD capability maturity model in this study was guided by the design science research (DSR) principles, which are characterized by the intent to develop and test artifacts to solve complex problems (vom Brocke & Maedche, 2019). Therefore, this methodology exceeds the aim of understanding a phenomenon to attempt to change it by introducing novelty and innovation. DSR normally follows the cycle of identification of a problem, creating an artifact to solve that, and iterative testing and refinement to ensure effectiveness and utility. The iterative nature draws out the essential features of design science: dynamic, adaptive, and open to ongoing improvements or adaptations of the artifact based on feedback and changing requirements (Venable et al., 2016; vom Brocke & Maedche, 2019).

To further structure and guide this process, the methodology was enriched by the procedural frameworks of (Becker et al., 2009) and (De Bruin et al., 2005), which outline comprehensive procedures for maturity model development. These references complement the DSR approach by providing detailed procedures that ensure maturity models are developed with clear objectives and scope, thorough comparative analysis with existing models, and iterative development cycles. Accordingly, the development of this model involves five main stages, each designed to build upon the insights and foundations established by the preceding stages, followed by a validation and feedback step, as shown in

Figure 3.1.

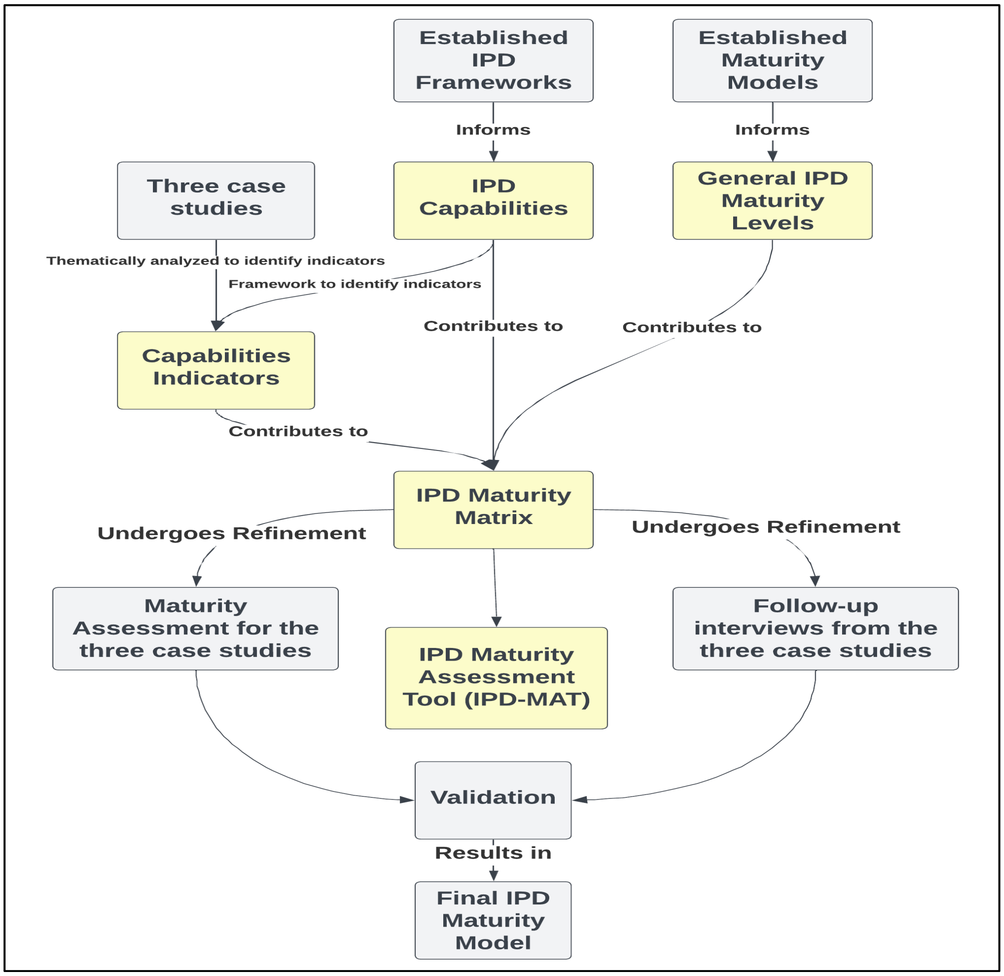

Figure 3.1 IPD Capability Maturity model development process flowchart

3.4.1 Developing the General IPD Maturity Levels

To establish general maturity levels for IPD, the process begins by analyzing existing maturity models across various domains. This cross-disciplinary review aims to identify common patterns and effective strategies that have been successful in other fields such as Human Resources, IT, Project Management, Supply Chain Management, Digital Transformation, Lean, and BIM. These models provided an understanding of the strategies, structure, and patterns of the progression of maturity from one level to another within this wide range of fields (Becker et al., 2009). Understanding these patterns provided valuable insights into how different maturity levels might be framed and evolved in the context of IPD, using approaches that proved effective in other fields.

3.4.2 Defining IPD Capabilities

Following the establishment of the general IPD maturity levels, the next step was to define IPD capabilities, supported by a thorough review and analysis of existing IPD frameworks, as documented in several key sources listed in sec 3.2.2. Each framework was meticulously examined to identify and consolidate essential capabilities for successfully implementing IPD projects. This exercise involved synthesizing the phases, practices, procedures, and distinct capabilities included in these frameworks, showing how exactly they engage and enable the efficacy of IPD.

To identify and validate the capabilities, a systematic process that entailed a comparison of components across various frameworks to identify common themes was conducted. Through this comparative examination, crucial capabilities that were commonly stressed as part of successful IPD implementations were identified. This was to ensure that the capabilities were rooted in the well-established practices and theoretical foundations of IPD.

All the capabilities were then grouped according to their capacity to impact certain aspects of project delivery, for instance, contract development, project governance, and management and oversight. This categorization process was crucial for ensuring that each capability was theoretically valid and practically applicable. Furthermore, the R&D framework (Arar et al., 2024), developed in the preceding stage of this research project, was utilized as a guiding template in mapping each capability set to a particular aspect of the IPD deployment. It was important that this mapping enabled each capability to be contextualized in the lifecycle of the IPD project, to ensure it is valid and can sustainably support different phases of project delivery.

3.4.3 Identifying IPD Capabilities Indicators

In the third step, a thematic analysis of three IPD case studies was conducted to identify capabilities indicators and their maturity levels extracted directly from practical implementations of IPD. The capabilities that were identified in the previous step acted as a coding framework. Therefore, the process formalized the observable behaviors, norms, policies, activities, tools, and practices that represent the indicators of IPD capabilities and their different maturity levels of implementation. This approach validates the capabilities identified in the previous phase and ensures that the maturity model reflects real-world complexities and interactions. The resulting indicators serve as measurable elements translated into assessment statements within the Maturity Assessment Tool developed in the following steps.

Three case studies were chosen to provide real-world settings for the capabilities. These cases possess a diverse range of asset types, locations, sizes, and scopes, thereby providing a broad understanding of various contexts in IPD. The dataset comprises 37.7 hours of stakeholder interviews, insights from survey responses from 36 team members, and over 100 project documents. Part of the data regarding these three cases was reported in detail in (Poirier et al., 2022), in a study that investigated the success factors of IPD.

- **Case study 1**: A municipal aquatic facility in British Columbia, Canada was renovated and enhanced with the goals of improving resilience, energy efficiency, and reducing greenhouse gas emissions.
  Project Type: Renovation and upgrade. Building Type: Sport faculty. Project Budget: $14,000,000. Project Schedule: 15 months. Number of Signatories: 10.

- **Case study 2**: Two state-of-the-art educational institutions were built in Alberta, Canada, underpinned by the principles of 21st-century learning and design.
  Project Type: New construction. Building Type: Educational. Project Budget: $45,000,000. Project Schedule: 38 months. Number of Signatories: 13.

- **Case study 3**: A shared infrastructure in Ontario, Canada was developed through collaboration between two public entities, intended for three distinct first responder agencies. A centralized campus was designed to streamline the planning and execution of programs for these responders.

Project Type: New construction. Building Type: Emergency services. Project Budget: $85,000,000. Project Schedule: 38 months. Number of Signatories: 15.

3.4.4 Developing the IPD Maturity Matrix

In the fourth step, the IPD maturity matrix was developed by systematically integrating the general maturity levels with the IPD capabilities identified earlier. To develop the framework, the process involved laying out the capabilities along one axis and the maturity levels along another. Each intersection in the matrix was then assessed to determine the extent to which a particular capability demonstrated characteristics of a given maturity level, based on indicators identified in the previous steps.

This step was important for categorizing each capability into detailed maturity levels, allowing for the assessment of IPD practices maturity. The resulting matrix provided a clear representation of where each capability stood in terms of development and implementation.

3.4.5 Creating the IPD Maturity Assessment Tool (IPD-MAT)

This step involved transforming the IPD maturity matrix into a user-friendly tool called the IPD Maturity Assessment Tool (IPD-MAT). Designed to be applied at the conclusion of a project, the IPD-MAT facilitated a structured evaluation of how IPD practices were implemented relative to established maturity levels. This tool, structured as a questionnaire, utilizes a five-point Likert scale to allow users to assess the maturity level of their IPD projects across the identified capabilities. Each capability is broken down into key indicators to allow for a detailed evaluation. The tool was designed with a scoring system that enabled the determination of the maturity level for each capability within the project, as detailed in Section 3.5.5.

3.4.6 Validation and Feedback

In accordance with the Design Science Research, the validation process emphasized the artifact's utility and applicability in real-world project settings based on user feedback. This targeted feedback approach is not merely about achieving broad generalizability. Rather, the artifact is judged based on its utility, which is crucial for refining the model's practical effectiveness and ensuring its relevance to the specific contexts of IPD projects [26, 27]. Therefore, the validation of the study findings was conducted through a series of interactive sessions tailored specifically to assess the tool and the model's applicability on actual projects.

The process involved returning to the case studies that served as the basis for development. The efforts resulted in engaging two cases in the validation process, while the efforts to engage the third case were unsuccessful due to the project team's unavailability. From these two projects, a total of three interviews were conducted with two key stakeholders, namely the owner representatives. These individuals were selected based on their direct involvement in project decision-making, governance, and implementation, which positioned them well to assess the utility and accuracy of the maturity model and assessment tool.

Validation activities were structured to assess the model's applicability, gather feedback, and support refinement of the tool. This was achieved through a three-step process:

- **Evaluation Sessions**: These sessions entailed administering the IPD Maturity Assessment Tool questionnaire to owners' representatives to assess the maturity levels of various capabilities within their projects.
- **Maturity Reporting**: After the evaluations, detailed reports were compiled to outline the IPD maturity of identified capabilities in each project, providing a detailed overview of current practices and maturity levels.
- **Feedback Interviews**: Follow-up interviews were conducted with these stakeholders to discuss the findings detailed in the reports and evaluate the overall utility of both the Assessment Tool and the maturity model.

3.5 The IPD Capability Maturity Model (IPDCMM)

The overall findings of this study resulted in the IPD Capability Maturity Model articulated through five distinct yet interconnected elements. The elements include (1) IPD Maturity Levels, (2) IPD Capability Sets, (3) IPD Capabilities Indicators, (4) IPD Maturity Matrix, and (5) IPD Maturity Assessment Tool.

3.5.1 IPD Maturity Levels

A maturity level is an indicator that allows for a stepwise distinction between immature and mature entities/processes/projects regarding a certain approach or method. It refers to clearly outlined evolutionary stages that introduce and establish new skills/capabilities for skill development within an organization/project (Sarshar et al., 2000, as cited in Succar, 2010). To develop maturity levels for IPD, various established maturity models, were synthesized and tailored to form unique levels of IPD. This was done by observing and comparing the patterns among this diverse range of maturity models and reflecting them on the IPD maturity levels as detailed in **Table 3.2**.

The first pattern observed was the progressive sophistication from a basic understanding of an approach to the advanced level of capability and optimization, often in five or six stages, as exemplified by models such as P-CMM, COBIT, SCM and SPICE. In this research, the IPD Capability Maturity Model is designed with a baseline assumption that all assessed projects have implemented IPD at some level by the time of their post-project completion evaluation. Consequently, the model begins at what is termed the 'Initial' level, where basic IPD practices are already in place. This is in contrast to the typical starting point of 'Level 0' or 'non-existent' level suggested by (Becker et al., 2009) and (De Bruin et al., 2005), where no practices are assumed to be present. Incorporating a 'Level 0' would not be suitable for this model, as it specifically targets projects that have already adopted the IPD approach, therefore assuming the existence of some foundational IPD practices.

Table 3.2 IPD Maturity Levels

#	Maturity Level	Description
Level 1	Initial	IPD capabilities are at their foundational level. Practices related to IPD are not yet fully developed, with limited systematic application across the project.
Level 2	Defined	Basic IPD capabilities are established, although their application may still be inconsistent. Practices are in the early stages of systematic development but need further refinement for consistency.
Level 3	Managed	IPD capabilities are developing steadily, with partial consistency in their application across the project. Key practices are becoming more established, though some variability and gaps may still exist in their execution.
Level 4	Proficient	IPD capabilities are well-developed, consistently applied, and deeply integrated into project management activities. Practices are standardized and effectively adopted across the project, demonstrating a high level of maturity.
Level 5	Advanced	IPD capabilities are fully developed, integrated, and continually optimized for maximum effectiveness. Practices reflect innovation and are continuously improved to enhance project outcomes.

The second pattern observed was regarding level 1, where capabilities are still emerging and inconsistently applied, illustrated by models such as SPICE, SCM, 301in, and OBIMA. Therefore, the first level in the IPD maturity levels has been identified as Initial reflecting an early stage of IPD implementation where capabilities related to IPD could be limited or inconsistently applied. The third pattern, concerning the beginning of standardization and effective management, is seen in models such as OBIMA, SPICE, SCM, and BIM Maturity Matrix (BIMMM). Consequently, the second and third levels have been identified as Defined and Managed respectively, emphasizing the beginning of establishing and consistently applying IPD practices. Moving to the higher levels, another pattern was observed regarding Level 4, where practices are applied and deeply embedded in the project, as noticed in models such as 301in, SPICE, and OBIMA. Therefore, level 4 in IPD maturity levels is characterized as Proficient reflecting that IPD practices are deeply embedded in the project's culture.

The last pattern was the notion of advanced implementation, which represents continual optimization and innovation as a sign of advanced maturity as observed in models like COBIT, and SPICE. Therefore, the last stage in IPD maturity levels, level 5, is characterized as Advanced where capabilities related to IPD are highly developed and continuously improved to enhance project performance and outcomes.

3.5.2 IPD Capabilities

Identifying the IPD capabilities was based on a review of established IPD frameworks listed in **Table 3.1**, which served to inform the development process. The analysis involved an examination and synthesis of these frameworks to integrate their key thematic elements into a unified set of capabilities. This approach facilitated the creation of a set of capabilities that aim to be as extensive as possible in their coverage and tailored to the practical application of IPD. The process resulted in the identification of 21 capabilities, categorized into six main sets as detailed in **Table 3.3**, providing the foundation for developing the IPD maturity model.

Understanding and Facilitation Capability Set: This set focuses on establishing a robust understanding of IPD principles and processes to effectively adopt and implement this approach. This is represented in two capabilities: "IPD Comprehension," which focuses on equipping team members with a comprehensive knowledge of IPD fundamentals, and "Facilitation," which concerns establishing an effective facilitation process that addresses any gaps in the team IPD knowledge and provides training on new tools and techniques. In addition, this set includes strategic efforts for building a cohesive team culture, "Building and Sustaining Teams," to reflect the values of mutual respect, trust, shared responsibility, and working collaboratively.

Goal Setting and Contract Development Capability Set: This capability set focuses on aligning project team members around shared goals and values and integrating these principles into formal agreements that manifest a true IPD contract. The capability "Developing Project Goals (Validation Process)" involves collaboratively determining project specifics, including design, budget, and timeline, in a workshop setting and translating these specifics into clear, measurable, and achievable goals. The "Defining Project Values" capability is crucial for clearly defining and communicating the project's core values, ensuring they are referenced throughout the decision-making process and that there is a commitment to these values from the entire team. Lastly, the "Contract Formulation" capability represents the legal knowledge and awareness to create contracts that integrate IPD principles, enhance collaboration, and support the transparent and integrated nature of IPD projects.

Table 3.3 IPD Capability *Framework*

Set	Capability	Capability Indicators
Understanding and Facilitation	**IPD Comprehension**	**(1)** Understanding of IPD Principles and Processes**, (2)** Recognition of the Relevance of IPD to Project Success, **(3)** Integration of IPD in Execution, **(4)** Adaptation of IPD Practices Based on Project Needs.
	Facilitation	**(1)** Assessment of Gaps in Understanding of IPD Practices, **(2)** Training of on IPD Tools, **(3)** Effectiveness of Facilitation in Enhancing IPD Understanding, **(4)** Contribution of Facilitation to Culture Establishment.
	Building and Sustaining Teams	**(1)** Establishment of Team Culture, **(2)** Implementation of Flat Hierarchy, **(3)** Open Communication, **(4)** Encouragement of Participation, **(5)** Continuous Improvement of Team-Building Methods.
Goal Setting and Contract	**Developing Project Goals (Validation Process)**	**(1)** Validation Process, **(2**) Collaboration in Validation, **(3)** Participation in Validation, **(4)** Impact of validation on team culture, **(5)** Defining Project Goals, **(6)** Clarity and Comprehensiveness of Validation Report, **(7)** Introduction of New Methods in Validation.
	Defining project values	**(1)** Defining Core Values, **(2)** Communication of Values, **(3)** Reference to Values in Decision-making, **(4)** Revisitation of Values, **(5)** Strengthening of Values Through New Methods.
	Contract Formulation	**(1)** Participation in Contract Formulation, **(2)** Integration of All IPD Principles, **(3)** Utilization of Facilitation Means, **(4)** Contract Optimization.
Project Governance	**Defining Roles and Responsibilities**	**(1)** Definition of roles and responsibilities, **(2)** Overlaps and conflicts, **(3)** Discussion of Roles and Responsibilities, **(4)** Communication of Roles and Responsibilities, **(5)** Understanding of Roles and Accountability, **(6)** Adaptation of Roles.
	Establishing Decision-Making Process	**(1)** Inclusion in Decision-Making, **(2)** Transparency in Decision-Making, **(3)** Guidance by Project Goals, **(4)** Use of Decision Tools, **(5)** Decision Outcomes, **(6)** Documentation of decisions, **(7)** Adaptability and Agility in Decision-Making.
	Establishing Management Structure	**(1)** Defining Management Structure, **(2)** Coordination of Activities Across Management Levels, **(3)** Coordination of Decisions, **(4)** Adaptability of management strategies, **(5)** Integration of New Management Strategies.
	Owner involvement	**(1)** Involvement in Decision-Making, **(2)** Involvement in Day-to-Day Operations, **(3)** Role in Project Governance, **(4)** Support for the IPD Model, **(5)** Contribution to Collaborative Environment, **(6)** Contribution to Team Culture, **(7)** Leadership.
Operational Excellence	**Operational Culture**	**(1)** Promotion of Lean Practices, **(2)** Support for a Collaborative Work Environment, **(3)** Adoption of a No-Blame Culture, **(4)** Assessment and Implementation of Practices Enhancing Lean Culture, **(5)** Encouragement of New Methods to Enhance Collaborative Culture.
	Operational Principles	**(1)** Streamlining of Workflows, **(2)** Emphasis on Waste Reduction, **(3)** Emphasis on Value Maximization, **(4)** Emphasis on Continuous Improvement, **(5)** Integration of Lean and IPD Principles, **(6)** Role of Operational Principles in Advancing Project Management Practices.
	Tools	**(1)** Use of BIM, **(2)** Enhancement of Collaboration and Communication through BIM, **(3)** BIM as Information Source, **(4)** BIM's Role in Information Quality, **(5)** Use of Lean Tools, **(6)** Integration of Lean Tools and Techniques Into Operational Practices.

Table 3.3 IPD Capability Framework (continued)

Set	Capability	Capability Indicators
	Dynamics	**(1)** Structuring of Multidisciplinary Teams, **(2)** Flexibility of Team Formations, **(3)** Definition of Responsibilities Within Teams, **(4)** Decision-Making Authority Within Teams, **(5)** Cross-Disciplinary Collaboration.
	Engagement	**(1)** Use of Formal Communication, **(2)** Direct and Informal Engagement, **(3)** Communication and Engagement Strategies, **(4)** Continuous Improvement of Engagement Techniques and Strategies.
	Work Environment	**(1)** Frequency of Big Room Meetings, **(2)** Big Room Setup, **(3)** Impact of Big Room Sessions on Engagement, **(4)** Impact of Big Room Sessions on Team Unity, **(5)** Impact of Big Room Sessions on Collaboration, **(6)** Incorporation of Advanced Tools and Techniques in Big Room Settings.
Management and Oversight	**Information Management**	**(1)** Information Structure, **(2)** Information Sharing, **(3)** Access to Data, **(4)** Use of Advanced Technologies to Enhance Data Utilization and Support Decision-Making.
	Financial Practices	**(1)** Integrating Team members in Financial Discussions, **(2)** Financial Transparency, **(3)** Financial Responsibility, **(4)** Use of Incentive Mechanisms, **(5)** Role of Incentive Mechanisms in Collaboration and Performance Enhancement, **(6)** Financial Decision-Making Tools.
	Risk Practices	**(1)** Risk Management Practices Inclusivity, **(2)** Frequency of Risk Management Practices, **(3)** Use of Collaborative Tools, **(4)** Risk Ownership, **(5)** Improvement of Risk Management Practices.
	Performance Monitoring	**(1)** Use of Dashboards, **(2)** Data Collection and Analysis, **(3)** Adaptation of Metrics, **(4)** Metrics' Role in Decision-Making, **(5)** Data and Metrics updates.
Continuous Learning	**Continuous Learning and Improvement**	**(1)** Capture of Lessons Learned, **(2)** Analysis of IPD Practices Feedback, **(3)** Analysis of Stakeholder Feedback, **(4)** Assessment of Client Satisfaction, **(5)** Feedback Integration, **(6)** Continuous Improvement in Feedback Capturing and Utilization.

Project Governance Capability Set: This capability set focuses on establishing governance mechanisms in IPD projects, which is essential for defining roles, enhancing decision-making, and ensuring effective management and owner involvement. The "Defining Roles and Responsibilities" capability involves setting clear roles, responsibilities, and accountability structures within the IPD team to promote an efficient work environment. This fosters a clear understanding among team members of their duties and expectations and enhances overall project coordination. The "Establishing Decision-Making Process" capability is key to establishing a framework that supports transparency, inclusivity, and collaboration. It is designed to ensure that all decisions are guided by the overarching project goals and values. The "Establishing Management Structure" capability develops a multilayer management framework that effectively outlines different roles and ensures seamless project execution and coordination. Lastly, the "Owner Involvement" capability emphasizes the owner's active participation in both decision-making and day-to-day project management, essential for championing the IPD approach throughout the project lifecycle.

Operational Excellence Capability Set: This set focuses on the integration of BIM and Lean, fostering improved collaboration, communication, and multidisciplinary dynamics within IPD projects. The "Operational Culture" capability promotes a Lean and collaboration culture by embedding Lean values and fostering an environment of continuous improvement and a no-blame culture. The "Operational Principles" capability integrates continuous improvement, waste reduction, and value maximization principles with core IPD principles to enhance operational efficiency. "Tools" utilizes advanced tools and technologies, including BIM and Lean, to enhance collaboration and process efficiency. The "Dynamics" capability focuses on establishing and managing multidisciplinary teams that leverage collective expertise to solve problems and responding to project demands with efficiency and agility. "Engagement" promotes open and transparent communication among all project members, which is necessary for developing a participatory environment where ideas and feedback lead to better decision-making and project alignment. Lastly, the "Work Environment" capability optimizes physical and virtual spaces for collaboration, notably through the creation of a 'Big Room' environment that fosters inclusivity and immediate communication, enhancing overall project efficiency and culture.

Management and Oversight Capability Set: This capability set focuses on collaborative and transparent financial management, collective risk mitigation, information management, and integrated monitoring practices. The "Financial Practices" capability involves managing project costs and enhancing project value through transparent financial management. This includes involving team members in financial decision-making and fostering a culture of shared financial responsibility while maintaining individual accountability. It also involves designing and implementing incentive mechanisms that encourage sustained team collaboration. The "Risk Practices" capability focuses on a collaborative approach to risk management, jointly identifying, assessing, mitigating risks, and enhancing risk collective ownership within the project. This includes integrating all team members in the process using collaborative tools and practices for effective risk management. The "Information Management" capability is important for supporting collaborative decision-making, ensuring data consistency, and enhancing accessibility across the project team. Finally, the "Performance Monitoring" capability establishes and manages a set of unified metrics that synthesize data from all project members to track and measure key performance indicators, ensuring continuous monitoring and adjustment based on regularly updated data.

Continuous Learning Capability Set: This capability set focuses on promoting ongoing learning and the systematic integration of feedback within IPD projects. It establishes a culture of continuous learning and knowledge sharing to refine and enhance IPD practices. The "Continuous Learning and Improvement" capability involves systematically gathering, analyzing, and sharing lessons learned from the project, such as the effectiveness of IPD practices, client satisfaction, and stakeholder feedback. This process ensures that insights gained are actively utilized to drive project success and continuous improvement.

3.5.3 IPD Capability Indicators

In this stage of the study, the aim was to identify indicators for the previously defined capabilities, forming the final building blocks of the IPD maturity model and underpinning the development of the IPD Maturity Assessment Tool. Utilizing the capability sets as a coding framework, this phase concentrated on capturing the diverse behaviors, norms, activities, policies, and tools that exemplify the capabilities in action. A thematic analysis of data from three IPD case studies was conducted, and 112 different indicators were identified and categorized under 21 capabilities as illustrated in Table 3.3. The resulting indicators were grounded in empirical observations and contributed to defining the criteria within the maturity model. They represent the measurable elements that directly inform the assessment statements used in the IPD Maturity Assessment Tool.

This set of indicators underpins the model's utility by providing metrics for assessment across various dimensions of IPD implementation. For example, indicators for "Understanding and Facilitation" illustrate the depth of IPD comprehension and the effectiveness of facilitation mechanisms, such as recognizing the relevance of IPD to project success and evaluating the impact of training and facilitation on culture establishment and team building practices. For the "Goal Setting and Contract Development" set, capability indicators highlight the strategic basis of IPD projects. These indicators focus on collaborative and structured goal setting and assessing how project values are communicated and integrated into decisions, in addition to the indicators that concern how effective collaboration is in contract development and the incorporation of IPD principles. Furthermore, "Operational Excellence" includes several indicators under its six capabilities, which demonstrate how lean practices are emphasized, the use of technology like BIM, and the improvement of collaborative work environments, in addition to the details of the engagement and communication strategies and the aspects that impact the multidisciplinary team dynamics.

The indicators of the "Management and Oversight" set reflect aspects of information management, open-book accounting, and collaborative risk management processes. These represent how transparency, trust, and stakeholder engagement are fostered within the IPD project. Lastly, in the "Continuous Learning and Improvement" set, the indicators focus on the regular assessment and feedback and its integration and impact on continues learning to enhance IPD practices effectiveness and outcomes.

3.5.4 IPD Maturity Matrix

The IPD Maturity Matrix was designed to outline maturity levels across the different IPD capabilities. It combines three components identified in previous research phases: IPD Maturity levels, IPD Capabilities, and IPD Capabilities Performance Indicators. This matrix features a detailed layout of capabilities across different maturity levels from 'Initial' to 'Advanced,' allowing for a detailed examination of IPD implementation, as shown in **APPENDIX I (IPD Maturity Matrix)**.

The process involved mapping each IPD capability against its relevant performance indicators at successive maturity levels. This mapping involved examining how each capability manifested at different stages of maturity within real project environments. This real-world application perspective was brought into the process through the list of indicators extracted from three IPD case studies, showing how capabilities manifest at various maturity levels.

For instance, consider the capability of Facilitation, which includes indicators such as "Assessment of Gaps in Understanding of IPD Practices" and "Training of New Team Members on IPD Tools." In the first case study, the project team did not assess members' understanding of IPD principles, procedures, and tools; however, they did engage an external facilitator to conduct IPD training. The second case study showed a more robust approach: an assessment of IPD comprehension was carried out, followed by targeted training and facilitation. This was aided by including a facilitator into the team as a signatory member, allowing for continuous evaluation and addressing knowledge gaps. In contrast, the third case study lacked both the assessment of team understanding and a formalized training program on IPD, relying solely on internal facilitation. This example of the implementation of this capability demonstrates how the IPD Maturity Matrix's indicators can effectively capture the diversity in implementation approaches and demonstrate the distinct maturity levels across projects.

Therefore, this matrix can help the projects benchmark their IPD implementation and gather lessons that can aid them in strategically planning their developmental pathways toward advanced IPD practices in future projects.

3.5.5 IPD Maturity Assessment Tool (IPD-MAT)

In the final stage, theoretical frameworks established earlier were transformed into a practical artifact—the IPD Maturity Assessment Tool (IPD-MAT). This tool offers a practical way to systematically assess IPD practices, facilitating further improvements in the IPD approach. This tool leverages a structured questionnaire formatted with a five-point Likert scale to assess the maturity of IPD practices. The questionnaire was structured based on the capabilities' framework, and each question corresponds to a specific indicator within a capability set. These indicators, defined in the previous steps, serve as measurable elements that are translated into assessment statements within the IPD-MAT.

This approach resulted in a detailed assessment tool that includes 112 questions based on the indicators across 21 different capabilities. Each indicator has five possible responses, ranging from 'Strongly Disagree' to 'Strongly Agree,' each assigned a score starting from 1 for 'Strongly Disagree' to 5 for 'Strongly Agree.' The consolidated score for all indicators within a capability and the average score is calculated. Based on this average score, the maturity level is determined within the following intervals:

- Initial (1.0 - 1.9)
- Defined (2.0 - 2.9)
- Managed (3.0 - 3.9)
- Proficient (4.0 - 4.5)
- Advanced (4.6 - 5.0)

It is important to note that the maturity levels of 'Proficient' and 'Advanced' are conceptually closer to each other compared to the earlier stages, both representing a high level of capability and best practices within the processes. However, a crucial distinction is maintained between these two top tiers to underscore the pivotal role of innovation. This scoring strategy ensures that the 'Advanced' level is clearly linked to innovations in implementation, representing the peak of the maturity model.

3.5.6 Application and Validation of the Maturity Model and Assessment Tool

The model's and tool's utility and effectiveness in capturing the IPD implementation maturity levels were validated by assessing two case studies out of the three cases included in this research. While initial efforts were made to engage all three projects, only two responded positively and participated in the validation process. The third project team did not respond to follow-up communications and ultimately did not participate. As described in Section 3.6, this validation strategy was guided by Design Science Research principles, focusing on the artifact's utility and applicability rather than generalizability. This strategy emphasizes the utilization of feedback derived from real-world project implementations, which plays a significant part in improving and defining the maturity assessment tool. Engaged case study stakeholders provided key insights that were essential in verifying and improving the tool so that it could reflect actual-world usage. The validation process consists of three steps that include the assessment sessions for the two case studies, the development of a maturity report for both projects, and follow-up interviews with the projects' stakeholders for the purpose of discussing and commenting on the relevance and utility of the assessment tool and the maturity model.

The maturity assessment conducted for two cases (Case Study 1 and Case Study 3) demonstrated that even successful IPD projects exhibit varied capability maturity levels. For instance, the first case study showed a relatively high level of maturity, particularly excelling in the decision-making process and the collaborative work environment, which was rated as "advanced." However, lower maturity levels were observed in areas such as tools, information management, and facilitation, indicating gaps in the consistent application and integration of IPD tools. Comparatively, the third case study had a less mature implementation, with most of the capabilities being at the " managed " level. Exceptionally, some capabilities are graded as "advanced," such as the work environment, and some are graded as just "defined," such as the contract development capability.

The results of each project assessment were presented in a report that provides an executive summary and a quick overview of the maturity levels across the main capability sets, followed by detailed scores for each capability. For demonstration, Figure 3.2 illustrates the summary of capabilities assessment as it appears in the maturity report prepared for the third case study.

The follow-up sessions with stakeholders from the two projects provided important feedback, which led to some refinement and adjustment. One of the key outputs of the process was revisiting the scoring method for defining the five maturity levels. Configured initially with equal distribution, the process indicated a need for a recalibration of the scoring to more accurately mirror the difficulty of reaching the last maturity level, which is linked with signs of innovation in the implementation. Moreover, an issue was identified and corrected concerning a negatively worded question in the questionnaire that impacted the scoring metrics, thus improving clarity and accuracy in the evaluation process.

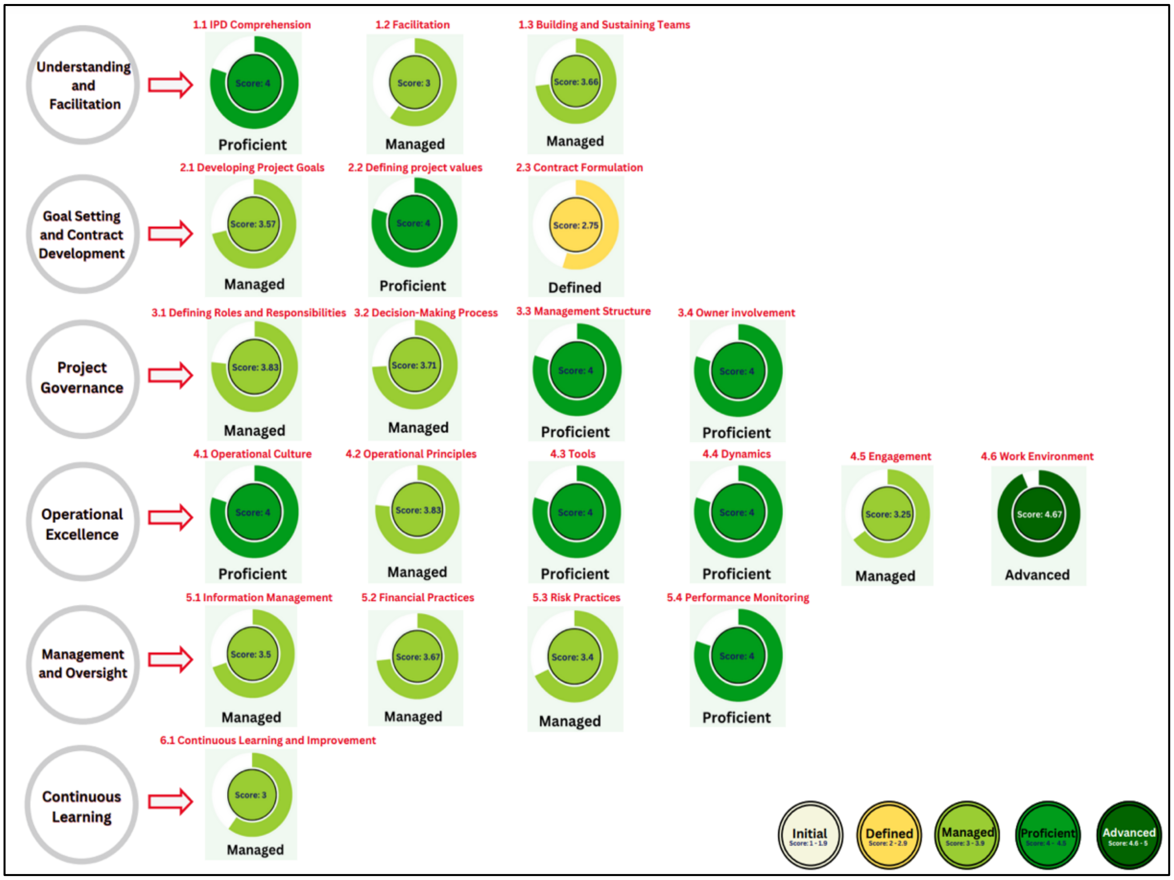

Figure 3.2 IPD Maturity Assessment Report – Case Study 3 – Summary of Capabilities

3.6 Discussion

The IPD Capability Maturity Model (IPDCMM) introduced in this study advances the field of IPD by offering a novel framework and artifact specifically designed to evaluate the maturity at the post-project phase as part of the learning process. By focusing on project-level evaluation, the IPDCMM facilitates targeted improvements that are directly actionable, providing a clear path for continuous refinement of IPD practices. Unlike existing models, the IPDCMM integrates empirical data from extensive IPD case studies with established theoretical frameworks, ensuring a robust foundation grounded in theory and practice and confirming the model's relevance to real-world applications.

Comparatively, IPDCMM aligns with the existing IPD frameworks in incorporating their core principles, contractual elements, and operational processes that differentiate IPD from other forms of project delivery. IPDCMM integrates and extends upon critical markers and thematic categories from seminal works in the field (e.g., (AIA, 2007, Ashcraft, 2012, Cheng & Johnson, 2016, Fischer et al., 2017, Allison et al., 2018, Poirier et al., 2022) to form a comprehensive capability framework that directly corresponds to practical IPD applications across diverse project settings and resulting in a structure that could be particularly beneficial for practitioners, providing them with a model and tool that reflects the actual dynamics of project implementation. However, the IPDCMM is distinguished from these frameworks by introducing a novel assessment tool that utilizes over 112 empirically derived indicators. This tool offers a detailed and structured evaluation of IPD practices, facilitating precise assessments and targeted improvements.

Furthermore, the IPDCMM aligns with established maturity models from other domains, including BIM, Lean, and project management (L. A. Initiative, 2001; Kwak & Ibbs, 2002; Succar, 2010), in that it follows a structured progression through distinct maturity levels that outline steps toward greater sophistication in implementing IPD practices. However, unlike many models developed for BIM and Lean Maturity that primarily focus on organizational-level practices, the IPDCMM is uniquely designed to evaluate IPD implementation at the project level and specifically during the post-project phase. Moreover, many existing maturity models are criticized for lacking solid theoretical backing and for being hypothesized without a precise indication of their practical application (Lasrado et al., 2015; Normann Andersen et al., 2020). This study directly addresses the need for a theoretical foundation for the maturity model by introducing the IPD capability framework that represents the theoretical underpinning upon which the maturity model was developed. In addition, this study addresses the need for precise practical application by introducing the maturity assessment tool. This tool ensures there is a clear pathway for how this maturity model can be effectively put into practice. The resulting tool offers a clear and structured means of evaluating maturity using 112 empirically derived indicators across 21 capabilities. Lastly, while many of the existing maturity models are developed without the support of empirical data, leading to critiques of their applicability and relevance (Normann Andersen et al., 2020), the IPDCMM is grounded in extensive data from three diverse IPD case studies, ensuring its relevance, applicability, and practical value in real-world project environments.

The IPDCMM was developed and validated using data from three case studies that represent a meaningful range of project types and sizes, with budgets spanning from $14 million to over $85 million. These projects varied in function, including sports facilities, emergency service buildings, and educational institutions, and encompassed new construction, renovation, and upgrade developments. This diversity adds a degree of confidence in the model's applicability across various construction contexts. However, further validation is recommended to assess its scalability and adaptability across an even broader spectrum of projects, such as smaller-scale developments, megaprojects, and projects in other industries that adopt similar IPD principles.

The IPDCMM is distinguished from traditional maturity models, which often focus on organizational maturity assessments, by specifically targeting the project level. This focus allows for a nuanced understanding of IPD practices within the dynamic context of individual projects, a perspective not commonly addressed by broader organizational models like the Supply Chain Management maturity model (Lockamy & McCormack, 2004), BIM QuickScan (Sebastian & van Berlo, 2010), and the BIM Maturity Matrix (Succar, 2010). Further, by concentrating on post-project reviews, the IPDCMM facilitates a detailed analysis of the practices implemented and the lessons learned, directly feeding into a continuous improvement cycle essential for IPD progression. Notably, while the direct evidence from this study is confined to project-level impacts, it is reasonable to speculate that consistent application of this model across multiple projects and continuous evaluation and refining of IPD practices may naturally extend IPDCMM benefits to organizational learning and, therefore, influence broader organizational maturity towards IPD.

On another note, the IPD-MAT presents further opportunities when envisioned as a digitized assessment tool, capable of supporting real-time data input, automated maturity scoring, and dashboard visualization, aligning with broader trends in digital transformation and intelligent systems within the construction sector.

That said, there are some considerations regarding the model and the artifact's scope limits. Specifically, the model's primary focus on the post-project phase pinpoints opportunities to apply it during earlier project stages, such as planning and pre-construction, and throughout the project duration remains largely unexplored. These phases offer critical opportunities for early intervention and continuous assessment that could further enhance project outcomes. Thus, extending the model to include readiness evaluations at project inception and ongoing assessments throughout the project lifecycle could significantly broaden its utility and impact.

Furthermore, while using a self-assessment approach in the tool can be effective in understanding and improving processes, it introduces a limitation in the form of subjectivity, where participants may hold biases toward their work, affecting the accuracy of the maturity (F. Lasrado, 2018). To mitigate individual biases, the assessment tool could be administered to all project parties to combine diverse insights for a more balanced view of implementation maturity, potentially reducing subjectivity. Moreover, implementing such a tool, if guided by an external evaluator or facilitator knowledgeable about the IPD, may also ensure objectivity. These approaches would lead to less bias and simultaneously increase the validity and reliability of results. Another practical consideration relates to the timing and engagement of project team members after project completion. In some cases, dispersed teams, staff turnover, or limited post-project availability may hinder the ability to conduct a comprehensive assessment. Ensuring the timely administration of the tool, ideally as part of a project close-out process, can help mitigate this implementation challenge.

3.7 Conclusion

This study introduces the IPD Capability Maturity Model (IPDCMM) alongside the IPD Maturity Assessment Tool (IPD-MAT), designed to enable a systematic evaluation of IPD practices and guide their advancement within the construction industry. The development of the model was guided by a DSR methodological approach that utilized three data sources: existing maturity models from other fields, established IPD frameworks, and three IPD case studies. The development of this model fills a notable gap in the literature, addressing the lack of dedicated tools to assess the varying levels of IPD implementation maturity at the project level.

The model comprises several key components: (1) IPD Maturity Levels, which provide a pathway for progression; (2) IPD Capabilities, identifying the skills and processes essential for successful implementation; (3) Capability Indicators that enable measuring capability levels; (4) the IPD Maturity Matrix, which aligns capabilities with maturity levels for detailed evaluation; and (5) the IPD Maturity Assessment Tool (IPD-MAT), a practical questionnaire-based tool for assessing project maturity. Combined, these components contribute to developing an IPD model that provides both diagnostic and developmental guidance for improving IPD implementation. The model and its components offer theoretical and practical insights that enable a structured evaluation and refinement of IPD practices.

The IPD-MAT operationalizes the IPD Maturity Matrix by translating its capabilities and indicators into a structured, questionnaire-based tool. This transformation involved converting 21 capabilities and 112 indicators into assessment statements rated on a five-point Likert scale, allowing practitioners to evaluate each capability’s maturity level. Scores are then averaged and mapped to one of five maturity levels—Initial, Defined, Managed, Proficient, and

Advanced. This scoring structure provides a clear diagnostic output and supports informed decision-making for continuous improvement.

The study's implications, although centered on project-level assessments, extend beyond individual projects, providing a framework for organizations to build maturity in their IPD practices over time. The maturity assessment of IPD practices reveals underlying weaknesses and highlighted strengths in a structured manner. This level of detail could help organizations and industry practitioners better understand the context and performance of their IPD projects, thereby enhancing their ability to objectively measure and systematically improve their IPD capabilities.

However, this research does not consider the Organizational-wide-ranging influences proposed here. Further research should, therefore, be specifically designed to consider how such a structured post-project evaluation approach might influence wider organizational practices and test the potential benefits of IPD Capability Maturity Model applications at organizational levels.

This research validation approach mainly involved revisiting two case studies from the three cases that contributed to the model's development by assessing each of these cases, followed by preparing a detailed maturity report and follow-up interviews to discuss the tool's relevance and utility. This methodological choice aligns with the principles of DSR in emphasizing the practical utility and effectiveness of the artifact based on application feedback rather than broad generalizability. However, future research could explore its application across a more diverse range of projects and contexts to further expand the model's applicability. This can contribute to a broader understanding of its effectiveness in varying IPD environments.

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CHAPTER 4

A READINESS MODEL FOR INTEGRATED PROJECT DELIVERY

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4.1 Abstract

As the construction industry continues to embrace Integrated Project Delivery (IPD) for its widely recognized benefits and efficiency improvements, the number of projects utilizing this approach is growing. Despite this trend, IPD represents a significant departure from the traditional, less collaborative, and integrated methods that have long dominated the industry. Consequently, practical experience with IPD remains in development. Therefore, a readiness model to evaluate project readiness to implement IPD becomes essential in order to target and develop the necessary capabilities. To address this gap, this paper introduces an IPD readiness model, that provides a detailed picture of readiness aspects around all IPD capabilities and helps set clear expectations for all project stakeholders getting involved in an IPD project. It also offers a structured tool for assessing and improving the readiness for IPD implementation, ensuring that teams, resources, and plans are aligned and capable of achieving the level of collaboration and integration that IPD demands. Guided by Design Science Research (DSR) principles, the methodology integrates a thorough understanding of existing gaps, leverages prior knowledge, and then develops and refines the readiness assessment tool, complemented by an application and validation step through two case studies. The Readiness Model includes three main components: an IPD Capability Framework, a Readiness Framework, and an Assessment Tool that classifies project readiness into five levels; Emergent, Low, Moderate, High, and Optimal, providing a structured path for assessing and advancing IPD project preparedness. This model lays the foundation for more standardized and consistent IPD implementation, ultimately contributing to its optimization as a collaborative approach within the construction industry.

Keywords: Integrated Project Delivery (IPD), IPD Readiness Model, IPD Capability, Readiness Assessment

4.2 Introduction

Integrated Project Delivery (IPD) is an innovative project delivery approach that emphasizes the collaboration and integration of stakeholders, systems, and practices throughout the project's different phases (Fischer et al., 2017). Since its inception, this approach has gained in popularity, reflecting the industry's increasing recognition of the importance of integration, collaboration and its need to find more collaborative approaches to the delivery of capital projects (Viana et al., 2020). As a novel approach, the full potential of IPD remains constrained by the need for more refined frameworks, mechanisms, and tools to optimize it's application and ensure a wider adoption across the industry (Rashidian et al., 2022; Arar et al., 2024).

This research builds upon a foundational study that developed a capability maturity model for IPD. The capability maturity model established a structured framework and tool to enable post-project evaluation of IPD practices, allowing projects to benchmark their practices against industry best practices and capture lessons learned to promote ongoing improvement (Arar et al., 2025).

While the utilization of the capability maturity model is primarily intended to assess the maturity of IPD practices at the post-project phase, some of its components, in particular, the capability framework and the capability indicators, have shown a potential to be also beneficial in addressing projects' readiness and needs to implement IPD at the initial project stages. This is due to its flexibility in capturing the various skills, processes, and tools required for implementing IPD in a structured and sequential manner.

To this end, the study presented in this paper aimed to develop an IPD readiness model. This model aims to enhance the project initiation phase by guiding all parties through the critical focus areas necessary for successful IPD implementation and setting clear expectations to align project efforts. It functions as an assessment tool that evaluates to what degree a project is prepared to embark on IPD implementation through structured evaluation. This focus on preparatory conditions sets readiness apart from maturity. Together, maturity and readiness models frame a structured approach, allowing for proactive planning and informed evaluation to enhance project execution (De Bruin et al., 2005). Therefore, the primary objective of the study presented in this paper is to develop the IPD readiness model by identifying its key components, creating a structured assessment tool tailored for evaluating IPD project implementation readiness, and validating the model through empirical research involving IPD case studies. The methodology employed involved revisiting and refining the capability indicators from the IPD maturity model developed in Arar et al. (2025) to focus on readiness for project initiation. This involved classifying indicators into leading, lagging, and continuous categories, selecting those indicating preparedness. The IPD Readiness Framework was then developed, incorporating these indicators into a structured framework that includes IPD capabilities, readiness indicators, and readiness checkpoints. Then, this framework was transformed into a readiness self-assessment tool with binary yes/no questions evaluating all indicators based on a scoring system linked to five readiness levels (Emergent, Low, Moderate, High, and Optimal). This tool was then validated through collaboration with several organizations, and the tool was applied to two IPD projects. Readiness assessments were conducted for these cases, followed by stakeholder feedback sessions to refine the model and tool further based on their feedback.

This paper begins by providing a brief overview of IPD, highlights gaps in existing practices, and discusses the IPD maturity model that underpins this study. It also delves into the concept of readiness and readiness for organizational change theory. The methodology section then outlines how the IPD capability maturity model elements are adapted into the readiness context, developing the readiness framework, the readiness tool, and the validation approach. The next section represents the resulting model, outlining its different components. Lastly, finding are discussed and a conclusion with a summarising the key findings is provided.

4.3 Background

This background section is structured in three parts to provide a foundation for the proposed IPD readiness model. The first part reviews key constructs and models used to assess readiness across disciplines, highlighting its multi-level nature and role in managing change. The second focuses on readiness in the specific context of IPD, highlighting gaps in the current literature. The third outlines prior work on IPD maturity and explains how it serves as a basis for developing a readiness model tailored to evaluate and guide project preparedness for IPD implementation.

4.3.1 Readiness Models

Readiness assessments across many disciplines are key in strategic planning and implementing new methodologies or technologies effectively. It involves carefully assessing technological, organizational, or psychological preconditions that need to be met before implementing innovations or changes (Dalton & Gottlieb, 2003). Ensuring the project readiness at the initiation phase is critical for aligning strategic objectives with operational readiness. Integrating readiness assessment into project planning to manage risks associated with unpreparedness can lead to substantial inefficiencies, which was found to be an effective strategy in project management. This importance for readiness becomes particularly relevant in the context of innovative and relatively new delivery systems such as IPD, which contrasts with most traditional construction practices and necessitates a thorough evaluation of readiness to ensure successful implementation.

Although this study focuses on readiness for implementing IPD at the project level, it draws on existing theories of organizational readiness for change. These theories articulate multidimensional and multi-level aspects of readiness and offer a robust foundation for understanding the complexities involved in preparing projects to adopt a new approach that departs from common industry practices (Holt et al., 2007; Weiner, 2020). This transition involves four key dimensions: the process of change, the content of what is changing, the context in which the change occurs, and the actors involved in or affected by the change. Proper consideration and alignment of these dimensions are crucial for successfully executing change initiatives Holt et al., 2007).

The readiness concept can be traced at various levels, which in turn include organizational, project-specific, and individual capabilities that together allow the successful adaptation of new processes or implementation of innovation (Lehman et al., 2002; Holt et al., 2007; Schumacher et al., 2016; Weiner, 2020). Organizational readiness generally covers broad assessments of an entity's preparedness for adopting innovations or changes. This will consider the strategic alignment of organizations, processes, and cultures with new methodologies to verify whether the whole entity is ready to address the proposed changes (Hanafi et al., 2016; Weiner, 2020; Magalhães et al., 2023) . Project-specific readiness, on the other hand, focuses on conditions that should be in place to enable specific projects or initiatives to succeed. It ensures that the critical elements needed to execute the project successfully, like resources, stakeholder alignment, and project goals, are all in a favorable position to proceed with the project and support its successful implementation (Liao et al., 2020; Britel & Cherkaoui, 2021). Individual readiness concerns individual prepossessions and attitudes toward innovations or changes. It concerns aspects like optimism, innovativeness, and insecurities in individual attributes that can relate to the likelihood of embracing innovations or changes (Parasuraman, 2000; Holt et al., 2007; Liu et al., 2019). This broad application of readiness emphasizes the importance of ensuring favorable conditions and a complete setup to implement new solutions.

Within organizational contexts, readiness for change is also underlined through a dual-component model that outlines the psychological and social aspects of organizational adaptation, namely the change commitment and change efficacy. Commitment to change refers to the collective concern and determination of the members within an organization in the pursuit and support of change. This shows the psychological preoccupation with the process of change. On the other hand, change efficacy relates to the collective belief in their ability to effectuate change successfully; this includes skill sets and resources within the organization. These components are essential for fostering an environment conducive to change by ensuring that all members are willing and capable of contributing to the transformation efforts (Weiner, 2020).

Additionally, some studies in the literature have adopted an approach that classifies readiness into distinct stages to simplify the identification of readiness evaluation outcomes and the necessary interventions to enhance it. For instance, readiness has been categorized into stages such as pre-contemplation, contemplation, and preparation, which reflect different levels of organizational willingness and capacity for change (Vax et al.,2021). Similarly, NOAA's R&D readiness levels provide a structured framework that categorizes readiness in terms of technology and operational capability into nine levels (NOAA 2022). This stage-based approach helps in pinpointing the appropriate interventions tailored to specific readiness levels to promote successful implementation initiatives (Vax et al.,2021).

These foundational perspectives on readiness represent crucial considerations in the development of the IPD readiness model. As outlined above, the literature supports a multi-level approach that distinguishes between organizational, project-specific, and individual factors, which guides this study’s focus on project-level readiness. Additionally, concepts such as change commitment and change efficacy help frame the conditions under which project teams are both willing and able to implement IPD. Finally, stage-based models of readiness offer a precedent for structuring readiness assessments progressively, aligning with the need to evaluate varying degrees of preparedness across IPD capabilities.

4.3.2 **Readiness in the Context of IPD**

The readiness assessment for implementing IPD reveals a critical, yet underexplored, area in the literature. Existing studies on IPD readiness are scarce and tends to focus either on organizational readiness to adopt IPD or on assessing how well projects align with IPD principles, rather than on the specific conditions, resources, plans, and alignment needed from the onset for successful implementation.

One notable effort involved developing a model focusing on IPD and Information and Communication Technology (ICT) readiness. This model primarily assessed how well projects aligned with IPD principles by evaluating ICT integration and identifying areas for improvement. This model served to determine the level of a project's alignment with IPD principles rather than evaluating the foundational conditions necessary for initiating IPD (Azhar, 2014). Another effort was made to address IPD readiness, through at the organizational level, within Malaysia's Industrialised Building System (IBS) sector, aiming to understand organizations' willingness to adopt collaborative project delivery methods. This research established a framework to gauge organizational alignment with IPD, providing insights into organization-level preparedness (Osman et al., 2015; Osman et al., 2017).

These studies, while valuable, focus on organizational readiness or the project's degree of alignment with IPD principles, leaving a gap in project-specific readiness assessments that consider the unique capabilities required for successful IPD implementation from the outset. Consequently, this research seeks to fill this gap by providing a theoretical framework and practical tools for assessing **the readiness for implementing IPD at the project level** regarding a wide array of IPD capabilities. Therefore, **this study defines readiness within the context of IPD as a critical early-stage assessment that determines a project's preparedness to undertake IPD by focusing on the essential capabilities, plans, resources, and alignment necessary for starting a new IPD project effectively**.

Building on this understanding, it is clear that while readiness assessment at the initiation phase of projects is crucial, the focus in current research, despite its scarcity, tends to be predominantly on organizational readiness or alignment with IPD principles. This leaves a notable gap for a readiness model specifically tailored to IPD at the project level, which would thoroughly address the detailed preparation of capabilities, resources, and alignments essential from the project's inception. This study aims to fill this gap by developing a readiness model that assesses and ensures all essential components are aligned to support successful IPD implementation. To support this effort, the next section outlines how the IPD capability maturity model developed in prior research provides the foundational components for constructing a project-level readiness model.

4.3.3 IPD from Maturity to Readiness

When it comes to established practices in the construction industry, IPD represents a revolutionary approach that runs counter to many established norms (Kent & Becerik-Gerber, 2010). It emphasizes integrating stakeholders, systems, and practices and fosters a culture where collaboration overrides traditional competition. It promises better project outcomes by ensuring joint project management and decisions, shared risks and rewards, mutual respect and trust, open book accounting, liability waiver, goal alignment, and above all, a no adversarial culture where people would like to work and collaborate (Matthews & Howell, 2005; Ghassemi & Becerik-Gerber, 2011).

However, despite its growing acceptance and proven benefits in enhancing project efficiency, IPD, as a relatively new approach, still has many hindrances to wider industrial diffusion. Among the main gaps, there is still a lack of distinct tools and frameworks that could allow an informed assessment of IPD capabilities, maturity, and readiness necessary to facilitate continuous improvement of IPD practices (Rashidian et al., 2022; Arar et al., 2024). While a capability maturity model dedicated to IPD was introduced in Arar et al. (2025), there remains a gap in frameworks and tools to enable informed readiness assessment, which is essential for assessing the preparedness of projects to embark on IPD implementation and, therefore, facilitate a path for more standardized and consistent IPD implementation.

The capability maturity model consists of several key components: the (1) Capability Framework constructed upon a cross-framework analysis of established IPD frameworks and represents a broad set of capabilities required for successful IPD implementation, (2) Capability Indicators were determined using empirical data from three IPD case studies. These indicators are evident in the practical elements of IPD such as behaviors, norms, policies, activities, tools, and practices that demonstrate the presence of IPD capabilities, the (3) Maturity Matrix that represents an evaluation framework for IPD maturity on a scale of five levels; Initial, defined, managed, Proficient, and advanced, and the (4) Maturity Assessment Tool that enables a structure evaluation for IPD implementation practices and determines its maturity. Collectively, these elements provide the mechanism for assessing the degree to which IPD practices have been implemented effectively, providing a methodological approach to capture and evaluate their maturity and facilitate their continuous improvement in (Arar et al., 2025).

For readiness purposes, this study adopted and built on the IPD capability framework presented in Arar et al. (2025) with its two key components: the IPD capabilities and capability indicators, shown in

Figure 4.1, to create a structured readiness model that guides project teams during the critical initial phases, ensuring all capabilities are aligned to successfully execute an IPD project. The IPD capability framework is constructed upon a detailed list of skills, processes, and tools required for successful IPD implementation, along with their corresponding indicators.

4.4 Methodology

This study aims to develop an IPD-specific readiness model to enhance the project initiation phase by guiding all parties through the critical focus areas required for successful IPD implementation, setting clear expectations, and aligning project efforts towards creating a

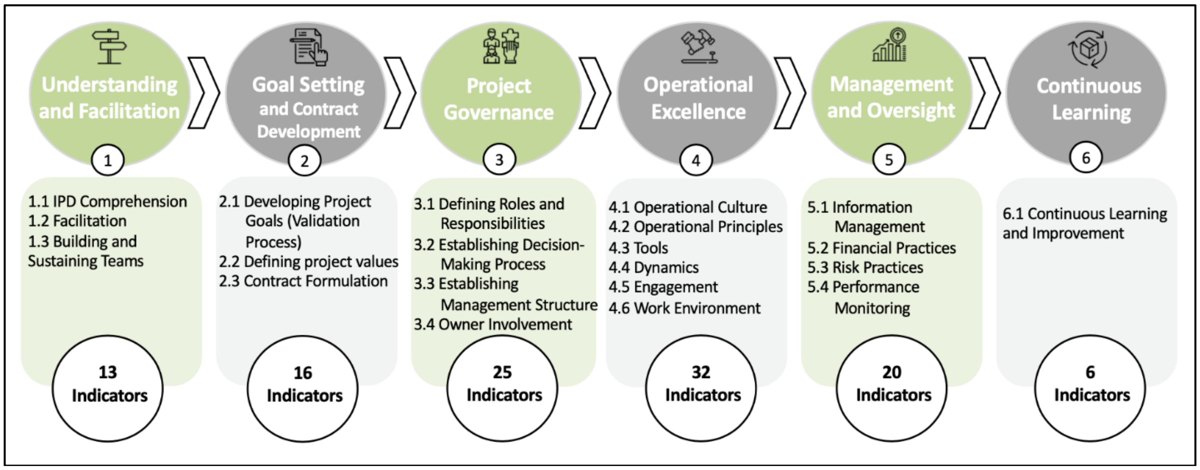

Figure 4.1 IPD Capability Framework

conducive project environment. The methodology of this study followed a pragmatic approach, designed to prioritize the achievement of specific outcomes. This approach involves adopting flexible methods to address emerging challenges and opportunities. The methodology employed in this research was guided by Design Science Research (DSR) principles that emphasize creating innovative and practical solutions -artifacts- namely, a readiness assessment tool (as an application of the proposed model) to facilitate informed evaluation of project readiness to implement IPD. This approach was implemented through a staged process of identifying the issues, leveraging existing knowledge, and then developing and refining the tool, which was validated through multiple case studies (Venable et al., 2012; vom Brocke et al., 2020).

Therefore, aligning with the DSR approach, the methodology involved the following four steps, as illustrated in Figure 3.1: (1) Adapting the IPD Capability Framework for Readiness Purposes, (2) Developing the Readiness Framework, (3) Developing the Readiness Assessment Tool, and (4) Validation through Case Studies.

4.4.1 Adapting the IPD Capability Framework for Readiness Purposes

Consistent with the DSR's focus on utilizing existing knowledge to create new, useful artifacts, a closer examination of the capability framework and capability indicators was performed by

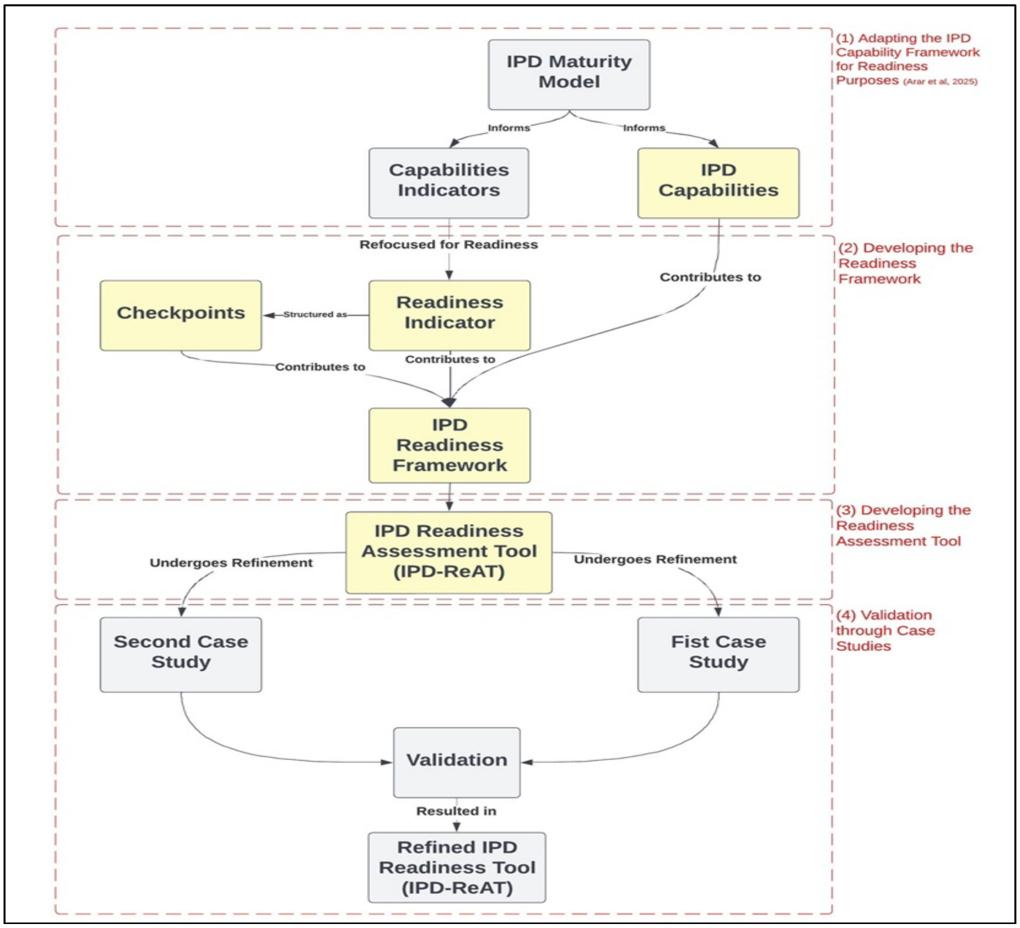

Figure 4.2 IPD Readiness Model Development Process

the research team to determine whether they can provide the framework necessary to develop the IPD readiness model. Notably, the indicators have varying focuses. While many of them are general leading indicators that represent the manifestation of the capabilities and enable their evaluation, some are retroactive indicators based on outcomes or represent continuous process evaluation. Therefore, initial examination revealed that some indicators might not suit readiness purposes. In this respect, these indicators require careful re-evaluation for readiness assessment purposes. This evaluation was performed based on criteria focused on each indicator's relevance and predictive quality for signaling readiness in IPD contexts. The criteria for evaluating the indicators included:

- Relevance: Each indicator was assessed for its direct relevance to the key dimensions of readiness in IPD, considering all IPD capabilities.

- Predictive Quality: Indicators were classified based on their ability to predict future project performance (leading), reflect past outcomes (lagging), or monitor ongoing project conditions (continuous) (Anderson & McAdam, 2004).

Based on this examination, the leading indicators were selected and relabeled as readiness indicators. These, along with the IPD capability list, formed the foundation for developing the readiness model and structuring the assessment tool.

4.4.2 Developing the Readiness Framework

In the next step, a framework synthesis process is employed to integrate and synthesize diverse components into a detailed matrix that maps out the interrelationships between IPD capabilities, readiness indicators, and readiness checkpoints (Brunton et al., 2020). The process begins by converting the readiness indicators carried from the previous step into detailed readiness checkpoints. These checkpoints are designed as detailed focus areas of the readiness indicators, crafted to act as specific readiness markers. Subsequently, the IPD Readiness Framework is constructed by integrating IPD capabilities, readiness indicators, and readiness checkpoints, following a structured approach aligned with readiness and maturity models in related fields (Chen et al., 2023; Jayanetti et al., 2022; Schumacher et al., 2016). This integration creates a cohesive framework that maps each capability to specific readiness measures (indicators and checkpoints), offering a framework of critical readiness aspects necessary for successful IPD implementation.

4.4.3 Development of the Readiness Assessment Tool

This step involves transforming the structured readiness framework into a practical self-assessment tool; the IPD Readiness Assessment Tool (IPD-ReAT). The tool is designed to act as a diagnostic and guidance tool that guides project teams in preparing for IPD implementation. To simplify the assessment process, the tool is organized as a series of binary Yes/No questions. A number of readiness indicators represent each capability, and each indicator is covered by one or more questions that enable the assessment of IPD capability readiness. The questions in this tool are specifically formulated to gauge the presence and efficacy of readiness indicators within the preliminary plans of a project.

The development of this tool draws from established practices in the literature, such as in Vax et al. (2021), which delineates organizational readiness into stages like pre-contemplation, contemplation, and preparation, and in NOAA (2022), which segments the readiness of R&D projects into nine levels. For this study, five readiness levels were defined for IPD projects: Emergent, Low, Moderate, High, and Optimal readiness. The criteria for each level, along with their respective scoring ranges.

4.4.4 Validation through Case Studies

Aligning with the DSR principles, this study adopts a naturalistic, ex post validation approach. This implies employing real-world IPD case studies (naturalistic) to assess the developed readiness tool (ex post) (Venable et al., 2012). To facilitate this validation, two public bodies organizations that are in the very early stages of implementing IPD within their projects were engaged.

The first organization used the tool to evaluate the readiness of an IPD project for an educational building in Quebec, Canada, which is still in its very early stages. The second public body, aiming to expand on collaborative practices and consider adopting IPD, used the tool to assess readiness for implementing IPD in a specific project under consideration: an upgrade for the mechanical systems of a commercial building in downtown Montreal, Canada.

The application of the tool in these projects aims to explore the tool's external validity, which is crucial for assessing its potential generalizability across different contexts (Egami & Hartman, 2023). In addition, the process established construct validity by gathering feedback from key representatives of the two case studies to confirm that the tool measures what it is intended to measure (Wolming & Wikström, 2010).

The validation process unfolds as follows:

- **Introduction of the Model**: Each organization is first introduced to the overall readiness model, followed by a detailed overview of the assessment tool, including its structure and the expected outcomes of its use.
- **Execution of the Assessment**: The tool is used in a self-assessment approach by owner representatives in both cases to evaluate readiness for the targeted IPD projects.
- **Feedback and Refinement**: Post-assessment, a detailed readiness report based on the outcomes was prepared for each project. Follow-up interviews are then conducted with key representatives from each project. In total, three follow-up interviews were conducted and involved six representatives from the two cases, representing the project management team or organizational members responsible for adopting or expanding collaboration practices. Feedback provided during these interviews touches on the clarity, relevance, and utility of the tool to lead to possible refinements.

4.5 IPD Readiness Model

The outcomes of this study led to the development of the IPD Readiness Model, which consists of two interrelated components designed to evaluate and guide the preparedness for IPD implementation. The components are: (1) the IPD Readiness Framework, which organizes essential IPD capabilities and related readiness indicators into actionable focus areas, offering a comprehensive structure to guide project planning and alignment; and (2) the IPD Readiness Assessment Tool (IPD-ReAT), designed to evaluate a project's readiness to begin implementing IPD. The development of these two components was complemented by application and validation steps that ensure the practical applicability and relevance of the readiness framework and assessment tool in real-world scenarios.

4.5.1 IPD Capabilities and Readiness Indicators

The IPD readiness model presented in this study is based on the IPD maturity model developed in (Arar et al., 2025). In particular, it builds on the two main components of the maturity model:

the IPD capabilities and their corresponding indicators. These indicators have been repurposed in this study to assess readiness at the initial stages of a project.

The review was performed according to the criteria provided in the methodology section (see Section 4.4.1) and involved a detailed classification of each indicator as leading, lagging, or continuous, based on their potential impact on the project. As shown in
Figure 4.1, a significant portion of the indicators (83) were classified as leading, indicating their critical role in the early detection of readiness and their applicability across all project phases, including the initial stage. Conversely, 18 indicators were deemed continuous, and 11 lagging, suggesting their suitability for ongoing assessments or outcome evaluation in later phases.

Table 4.1 IPD Capability Indicators Classification

Set	Capability	Capability Indicators Classified (Leading, Lagging, Continuous)
Understanding and Facilitation	**IPD Comprehension**	**(1)** Understanding of IPD Principles and Processes **(Leading), (2)** Recognition of the Relevance of IPD to Project Success **(Leading)**, **(3)** Integration of IPD in Execution **(Leading)**, **(4)** Adaptation of IPD Practices Based on Project Needs **(Continuous)**.
	Facilitation	**(1)** Assessment of Gaps in Understanding of IPD Practices **(Leading)**, **(2)** Training of on IPD Tools **(Leading)**, **(3)** Effectiveness of Facilitation in Enhancing IPD Understanding **(Lagging)**, **(4)** Contribution of Facilitation to Culture Establishment **(Leading)**.
	Building and Sustaining Teams	**(1)** Establishment of Team Culture **(Leading)**, **(2)** Implementation of Flat Hierarchy **(Leading)**, **(3)** Open Communication **(Leading)**, **(4)** Encouragement of Participation **(Leading)**, **(5)** Continuous Improvement of Team-Building Methods **(Continuous)**.
Goal Setting and Contract Development	**Developing Project Goals (Validation Process)**	**(1)** Validation Process **(Leading)**, **(2)** Collaboration in Validation **(Leading)**, **(3)** Participation in Validation **(Leading)**, **(4)** Impact of validation on team culture **(Leading)**, **(5)** Defining Project Goals **(Leading)**, **(6)** Clarity and Comprehensiveness of Validation Report **(Leading)**, **(7)** Introduction of New Methods in Validation **(Continuous)**.
	Defining project values	**(1)** Defining Core Values **(Leading)**, **(2)** Communication of Values **(Leading)**, **(3)** Reference to Values in Decision-making **(Leading)**, **(4)** Revisitation of Values **(Continuous)**, **(5)** Strengthening of Values Through New Methods **(Continuous)**.
	Contract Formulation	**(1)** Participation in Contract Formulation **(Leading)**, **(2)** Integration of All IPD Principles **(Leading)**, **(3)** Utilization of Facilitation Means **(Leading)**, **(4)** Contract Optimization **(Leading)**.
Project Governance	**Defining Roles and Responsibilities**	**(1)** Definition of roles and responsibilities **(Leading)**, **(2)** Overlaps and conflicts **(Leading)**, **(3)** Discussion of Roles and Responsibilities **(Leading)**, **(4)** Communication of Roles and Responsibilities **(Leading)**, **(5)** Understanding of Roles and Accountability **(Leading)**, **(6)** Adaptation of Roles **(Continuous)**.
	Establishing Decision-Making Process	**(1)** Inclusion in Decision-Making **(Leading)**, **(2)** Transparency in Decision-Making **(Leading)**, **(3)** Guidance by Project Goals **(Leading)**, **(4)** Use of Decision Tools **(Leading)**, **(5)** Decision Outcomes **(Lagging)**, **(6)** Documentation of decisions **(Leading)**, **(7)** Adaptability and Agility in Decision-Making **(Continuous)**.

Table 4.1 IPD Capability Indicators Classification (continued)

Set	Capability	Capability Indicators Classified (Leading, Lagging, Continuous)
	Establishing Management Structure	**(1)** Management Structure **(Leading)**, **(2)** Coordination of Activities Across Management Levels **(Leading)**, **(3)** Coordination of Decisions **(Leading)**, **(4)** Adaptability of management strategies **(Continuous)**, **(5)** Integration of New Management Strategies **(Continuous)**.
	Owner involvement	**(1)** Involvement in Decision-Making **(Leading)**, **(2)** Involvement in Day-to-Day Operations **(Leading)**, **(3)** Role in Project Governance **(Leading)**, **(4)** Support for the IPD Model **(Leading)**, **(5)** Contribution to Collaborative Environment **(Leading)**, **(6)** Contribution to Team Culture **(Leading)**, **(7)** Leadership **(Leading)**.
Operational Excellence	**Operational Culture**	**(1)** Promotion of Lean Practices **(Leading)**, **(2)** Support for a Collaborative Work Environment **(Leading)**, **(3)** Adoption of a No-Blame Culture **(Leading)**, **(4)** Assessment and Implementation of Practices Enhancing Lean Culture **(Continuous)**, **(5)** Encouragement of New Methods to Enhance Collaborative Culture **(Continuous)**.
	Operational Principles	**(1)** Streamlining of Workflows **(Leading)**, **(2)** Emphasis on Waste Reduction **(Leading)**, **(3)** Emphasis on Value Maximization **(Leading)**, **(4)** Emphasis on Continuous Improvement **(Leading)**, **(5)** Integration of Lean and IPD Principles **(Lagging)**, **(6)** Role of Operational Principles in Advancing Project Management Practices **(Continuous)**.
	Tools	**(1)** Use of BIM **(Leading)**, **(2)** Enhancement of Collaboration and Communication through BIM **(Leading)**, **(3)** BIM as Information Source **(Leading)**, **(4)** BIM's Role in Information Quality **(Lagging)**, **(5)** Use of Lean Tools **(Leading)**, **(6)** Integration of Lean Tools and Techniques into Operational Practices **(Leading)**.
	Dynamics	**(1)** Structuring of Multidisciplinary Teams **(Leading)**, **(2)** Flexibility of Team Formations **(Leading)**, **(3)** Definition of Responsibilities Within Teams **(Leading)**, **(4)** Decision-Making Authority Within Teams **(Leading)**, **(5)** Cross-Disciplinary Collaboration **(Lagging)**.
	Engagement	**(1)** Use of Formal Communication **(Leading)**, **(2)** Direct and Informal Engagement **(Leading)**, **(3)** Communication and Engagement Strategies **(Leading)**, **(4)** Continuous Improvement of Engagement Techniques and Strategies **(Continuous)**.
	Work Environment	**(1)** Frequency of Big Room Meetings **(Leading)**, **(2)** Big Room Setup **(Leading)**, **(3)** Impact of Big Room Sessions on Engagement **(Lagging)**, **(4)** Impact of Big Room Sessions on Team Unity **(Lagging)**, **(5)** Impact of Big Room Sessions on Collaboration **(Lagging)**, **(6)** Incorporation of Advanced Tools and Techniques in Big Room Settings **(Leading)**.
Management and Oversight	**Information Management**	**(1)** Information Structure **(Leading)**, **(2)** Information Sharing **(Leading)**, **(3)** Access to Data **(Leading)**, **(4)** Use of Advanced Technologies to Enhance Data Utilization and Support Decision-Making **(Leading)**.
	Financial Practices	**(1))** Integrating Team members in Financial Discussions **(Leading)**, **(2)** Financial Transparency **(Leading)**, **(3)** Financial Responsibility **(Leading)**, **(4)** Use of Incentive Mechanisms **(Leading)**, **(5)** Role of Incentive Mechanisms in Collaboration and Performance Enhancement **(Lagging)**, **(6)** Financial Decision-Making Tools **(Leading)**.
	Risk Practices	**(1)** Risk Management Practices Inclusivity **(Leading)**, **(2)** Frequency of Risk Management Practices **(Leading)**, **(3)** Use of Collaborative Tools **(Leading)**, **(4)** Risk Ownership **(Lagging)**, **(5)** Improvement of Risk Management Practices **(Continuous)**.
	Performance Monitoring	**(1)** Use of Dashboards **(Leading)**, **(2)** Data Collection and Analysis **(Leading)**, **(3)** Adaptation of Metrics **(Continuous)**, **(4)** Metrics' Role in Decision-Making **(Lagging)**, **(5)** Data and Metrics updates **(Continuous)**.
Continuous Learning	**Continuous Learning and Improvement**	**(1)** Capture of Lessons Learned **(Leading)**, **(2)** Analysis of IPD Practices Feedback **(Leading)**, **(3)** Analysis of Stakeholder Feedback **(Leading)**, **(4)** Assessment of Client Satisfaction **(Leading)**, **(5)** Feedback Integration **(Continuous)**, **(6)** Continuous Improvement in Feedback Capturing and Utilization **(Continuous)**.

4.5.2 IPD Readiness Framework

The IPD Readiness Framework was developed by incorporating IPD capabilities and previously identified readiness indicators into detailed checkpoints, which are specific markers derived from these indicators through a synthesis process (see Section 4.4.2). This integration forms a structured approach to evaluate and guide project readiness for IPD implementation. The synthesis of these elements provides a clear pathway to assess readiness, identify gaps, and plan developmental measures, ensuring projects are well-prepared to begin implementing IPD. This mapping, as shown in **Table 4.2**, serves as a theoretical framework upon which a practical tool for assessing readiness is developed in the next step.

Readiness for Understanding and Facilitation: The readiness for this set ensures that project teams are thoroughly prepared with foundational IPD knowledge and skills essential for successful implementation. **IPD Comprehension readiness** confirms the team's understanding of the IPD framework, principles, phases, and practices and how IPD contributes to project success. **Facilitation readiness** involves conducting assessments of gaps in understanding IPD practices, providing training on IPD tools, and emphasizing the contribution of facilitation practices to establishing a supportive culture. Lastly, **Building and Sustaining Teams readiness** ensures the establishment of a unified team culture, implements flat hierarchy structures to reflect joint management, and promotes open and direct communication, along with encouraging active participation from all team members, thereby fostering an environment where everyone's input is valued.

Readiness for Goal Setting and Contract Development: This set prepares teams for critical early-phase project planning and contractual agreements. Readiness in Developing Project Goals is centered around establishing a structured validation process that guides a clear definition of project objectives. This process ensures readiness by fostering collaboration to incorporate diverse perspectives and enhancing team culture—key elements that promote unity and a shared commitment to project goals. Readiness in Defining Project Values

Table 4.2 IPD Readiness Framework

Capability Sets	Capabilities	#	Readiness Indicator	Checkpoints
Understanding and Facilitation	IPD Comprehension	1.1.1	Understanding of IPD Principles and Processes	Ensure sufficient understanding of the IPD framework, principles, phases, and practices.
		1.1.2	Recognition of the Relevance of IPD to Project Success	Establish clarity on how IPD contributes to project success, highlighting its advantages over traditional delivery methods.
		1.1.3	Integration of IPD in Execution	Strategically plan to incorporate the principles of IPD into project execution plans.
	Facilitation	1.2.1	Assessment of Gaps in Understanding of IPD Practices	Conduct a detailed assessment of gaps in knowledge related to IPD practices.
		1.2.2	Training of on IPD Tools	Provide consistent training on IPD tools and techniques for all new members of the project.
		1.2.3	Contribution of Facilitation to Culture Establishment	Emphasize building a supportive IPD culture during facilitation practices.
	Building and Sustaining Teams	1.3.1	Establishment of Team Culture	Focus on fostering a unified and cohesive team culture, invest time and resources there, and recognize it as a key driver for success.
		1.3.2	Implementation of Flat Hierarchy	Implement flat hierarchy structures that reflect the joint management of the project.
		1.3.3	Open Communication	Encourage open and direct communication among team members.
		1.3.4	Encouragement of Participation	Encourage active participation from all team members, ensuring everyone's input is valued.
Goal Setting and Contract Development	Developing Project Goals (Validation Process)	2.1.1	Validation Process	Establish a structured validation process to effectively guide the development of project goals.
		2.1.2	Collaboration in Validation	Encourage collaboration, emphasizing the need to incorporate diverse perspectives effectively during the validation process.
		2.1.3	Participation in Validation	Emphasize inclusivity and active participation of all project team members during the validation process.
		2.1.4	Impact of validation on team culture	Use the validation process as an opportunity to enhance team culture, promoting unity and a shared commitment to the project goals.
		2.1.5	Defining Project Goals	Ensure that project goals are clearly defined and understood by all team members as a result of the validation process.
		2.1.6	Clarity and Comprehensiveness of Validation Report	Focus on the clarity and comprehensiveness of the validation report to provide a solid foundation for subsequent contract development and project execution.
	Defining project values	2.2.1	Defining Core Values	Ensure that the project's core values are well-defined and align with the overarching goals of the IPD project.
		2.2.2	Communication of Values	Ensure that core values are clearly communicated and understood by all project members.
		2.2.3	Reference to Values in Decision-making	Regularly reference the project's core values during the decision-making process to ensure that all decisions align with them.
	Contract Formulation	2.3.1	Participation in Contract Formulation	Ensure collaborative participation in contract formulation, involving all IPD project members actively.
		2.3.2	Integration of All IPD Principles	Integrate all IPD principles within the contract.
		2.3.3	Utilization of Facilitation Means	Employ various facilitation methods, such as workshops and expert consultations, to aid in the contract development process.

Table 4.2 IPD Readiness Framework (continued)

Capability Sets	Capabilities	#	Readiness Indicator	Checkpoints
		2.3.4	Contract Optimization	Optimize the contract to ensure it adapts to specific project conditions and fosters collaboration throughout the project.
Project Governance	Defining Roles and Responsibilities	3.1.1	Definition of roles and responsibilities	Ensure roles and responsibilities are clearly defined among the team.
		3.1.2	Overlaps and conflicts	Even with the project being jointly managed, work to minimize overlaps and conflicts within team roles.
		3.1.3	Discussion of Roles and Responsibilities	Facilitate comprehensive discussions involving all parties to agree on their roles and responsibilities within the project.
		3.1.4	Communication of Roles and Responsibilities	Ensure roles and responsibilities are communicated to all team members so they are informed and aligned.
		3.1.5	Understanding of Roles and Accountability	Ensure a deep understanding of the accountability structure, and each team member knows their responsibilities and the expectations placed upon them.
	Establishing Decision-Making Process	3.2.1	Inclusion in Decision-Making	Include all relevant IPD members in decision-making processes to foster inclusivity and collective responsibility.
		3.2.2	Transparency in Decision-Making	Conduct decision-making transparently to build trust and keep all team members informed and involved.
		3.2.3	Guidance by Project Goals	Guide all decisions by the overarching project goals to maintain consistency and focus throughout project execution.
		3.2.4	Use of Decision Tools	Employ decision-support tools effectively to assist in evaluating alternatives and making well-informed decisions.
		3.2.5	Documentation of decisions	Document all decisions comprehensively, providing clear context and rationale to support understanding and future reference.
	Establishing Management Structure	3.3.1	Management Structure	Establish a clear management structure with distinct roles and responsibilities across different levels (SMT, PMT, PIT).
		3.3.2	Coordination of Activities Across Management Levels	Promote effective coordination of activities across various management levels to provide clarity and effective governance.
		3.3.3	Coordination of Decisions	Ensure decisions are consistently aligned and effectively communicated across all management levels.
	Owner involvement	3.4.1	Involvement in Decision-Making	The owner should be actively involved in project decision-making.
		3.4.2	Involvement in Day-to-Day Operations	The owner should be directly involved and engaged in day-to-day project operations.
		3.4.3	Role in Project Governance	The owner should play a central role in project governance.
		3.4.4	Support for the IPD Model	The owner should fully embrace and advance the IPD model to facilitate successful adoption and implementation.
		3.4.5	Contribution to Collaborative Environment	The owner should actively contribute to fostering a collaborative environment.
		3.4.6	Contribution to Team Culture	The owner should actively contribute to creating a favorable team culture.
		3.4.7	Leadership	The owner should serve as a role model through leadership and commitment to the IPD approach.
Operational Excellence	Operational Culture	4.1.1	Promotion of Lean Practices	Promote the adoption and implementation of Lean practices throughout the project course.
		4.1.2	Support for a Collaborative Work Environment	Foster a work environment that encourages teamwork and collective problem-solving.

Table 4.2 IPD Readiness Framework (continued)

Capability Sets	Capabilities	#	Readiness Indicator	Checkpoints
		4.1.3	Adoption of a No-Blame Culture	Promote a no-blame culture that supports learning from mistakes.
	Operational Principles	4.2.1	Streamlining of Workflows	Promote streamlined workflows to enhance efficiency, positioned as a fundamental operational principle.
		4.2.2	Emphasis on Waste Reduction	Focus on minimizing waste across all project phases as a core operational principle.
		4.2.3	Emphasis on Value Maximization	Ensure value maximization is a key consideration in all project decisions, promoting its role as a key operational principal.
		4.2.4	Emphasis on Continuous Improvement	Commit to continuous improvement by regularly evaluating and enhancing project practices.
	Tools	4.3.1	Use of BIM	Utilize BIM effectively across various applications to support and enhance project processes.
		4.3.2	Enhancement of Collaboration and Communication through BIM	Leverage BIM to enhance collaboration and communication, positioning it as a pivotal element in project management.
		4.3.3	BIM as Information Source	Employ BIM as a reliable and comprehensive source of project information, ensuring data integrity and accessibility.
		4.3.4	Use of Lean Tools	Frequently use various Lean tools to streamline workflows and maximize project value.
		4.3.5	Integration of Lean Tools and Techniques Into Operational Practices.	Leverage the use of Lean tools and techniques as the core of the project's operational practices.
	Dynamics	4.4.1	Structuring of Multidisciplinary Teams	Structure teams (PITs) inclusively to integrate a broad range of disciplines effectively.
		4.4.2	Flexibility of Team Formations	Maintain flexible team formations that can adapt to changing project needs and dynamics.
		4.4.3	Definition of Responsibilities Within Teams	Clearly define responsibilities within teams to ensure clarity and accountability in task management.
		4.4.4	Decision-Making Authority Within Teams	Empower teams with the authority to make decisions relevant to their tasks.
	Engagement	4.5.1	Use of Formal Communication	Limit communication through formal channels to essential and legal correspondences only.
		4.5.2	Direct and Informal Engagement	Encourage direct and informal engagement among team members through various channels, including digital platforms and informal meetings.
		4.5.3	Communication and Engagement Strategies	Develop and implement inclusive communication and engagement strategies that keep all team members, including on-site personnel, well-informed and aligned with project objectives.
	Work Environment	4.6.1	Frequency of Big Room Meetings	Ensure Big Room meetings are held frequently (physical or virtual) to enhance team unity and maintain collaborative momentum.
		4.6.2	Big Room Setup	Design the Big Room setup to promote inclusivity and collaboration, featuring equal seating arrangements and no-title zones.
		4.6.3	Incorporation of Advanced Tools and Techniques in Big Room Settings	Utlize advanced tools and techniques in Big Room settings to enhance the effectiveness of sessions and facilitate collaboration.
Management and Oversight	Information Management	5.1.1	Information Structure	Organize information within the project in a structured manner that ensures clarity and easy accessibility.
		5.1.2	Information Sharing	Facilitate the sharing of information using digital platforms to ensure efficient dissemination.

Table 4.2 IPD Readiness Framework (continued)

Capability Sets	Capabilities	#	Readiness Indicator	Checkpoints
		5.1.3	Access to Data	Ensure real-time access to data for project members to facilitate timely decisions and responsiveness to project dynamics.
		5.1.4	Use of Advanced Technologies	Explore the opportunities to implement advanced technologies such as AI, digital twins, and VR to enhance data utilization and support decision-making processes.
	Financial Practices	5.2.1	Financial Discussions	Integrating all team members in financial discussions to foster a culture of shared financial responsibility.
		5.2.2	Financial Transparency	Employ open-book accounting to ensure transparency in financial activities.
		5.2.3	Financial Responsibility	Establish policies or practices to follow up on shared and individual financial responsibility to promote a mature culture of shared financial responsibility and solid individual accountability.
		5.2.4	Use of Incentive Mechanisms	Employ incentive mechanisms that enhance team performance and sustain collaboration throughout the project and in different scenarios.
		5.2.5	Financial Decision-Making Tools	Utilize advanced financial decision-making tools to support financial planning and execution.
	Risk Practices	5.3.1	Risk Management Practices	Engage all IPD members in risk management activities to ensure a uniform understanding and collective approach to risk mitigation.
		5.3.2	Frequency of Risk Management Practices	Implement regular risk assessments to address new and evolving risks.
		5.3.3	Use of Collaborative Tools	Regularly utilize collaborative tools, such as risk registers, to identify, assess, and manage risks effectively and facilitate decision-making.
	Performance Monitoring	5.4.1	Use of Dashboards	Implement dashboards to visualize a broad range of performance metrics such as budget, schedule, safety, culture, and more to enable broad oversight and quicker response.
		5.4.2	Data Collection and Analysis	Standardize data collection across all project disciplines and members to enhance the accuracy and reliability of performance analysis.
Continuous Learning	Continuous Learning and Improvement	6.1.1	Capture of Lessons Learned	Systematically capture and document lessons learned throughout the project duration.
		6.1.2	Analysis of IPD Practices Feedback	Regularly gather and analyze feedback on IPD practices to identify areas for improvement and reinforce successful strategies.
		6.1.3	Analysis of Stakeholder Feedback	Consistently collect and analyze stakeholder feedback to ensure project alignment with all participant expectations and needs.
		6.1.4	Assessment of Client Satisfaction	Continuously assess and address client satisfaction to respond to client needs effectively.

ensures that the project's core values will be well-defined, well-communicated, and regularly referenced during decision-making processes, ensuring all decisions align with overarching project values. **Readiness in Contract Formulation** ensures an active and collaborative participation in contract development. This includes stress on integrating all IPD principles into the contract and employing various facilitation methods, such as workshops and expert consultations, to aid the development process. Moreover, this readiness area emphasizes optimizing contracts to adapt to specific project conditions and to foster ongoing collaboration throughout the project lifecycle.

Readiness for Project Governance: This set's readiness focuses on preparing teams to implement the governance aspects of IPD by ensuring that roles are structured to facilitate effective project management. **Defining Roles and Responsibilities readiness** focuses on the existence of plans to ensure roles and responsibilities are clearly defined, communicated, and understood across the team. This includes fostering team discussions to ensure mutual agreement on roles, enhancing team alignment, and promoting a deep understanding of individual accountability. **Establishing Decision-Making Processes readiness** aims to ensure an inclusive and transparent environment where decision-making involves all relevant team members in decision processes, taking benefits of collaborative decision-support tools, and is consistently guided by overarching project goals. **Establishing a management structure readiness** ensures proper coordination at different levels of management, so that decisions and activities are aligned and duly communicated. And last, in this set, **Owner Involvement readiness** indicates active and continuous project owner involvement both at the decision-making level and at the level of everyday operations, encouraging a leadership role in governance and fostering a collaborative environment. This includes the owner's support for the IPD model and contributing to establishing a favorable team culture. This includes the owner's support for the IPD model and contributing to establishing a favorable team culture.

Readiness for Operational Excellence: This set concerns the team's preparedness to foster a cohesive and efficient operational framework. **Operational Culture readiness** confirms that the team is prepared to adopt Lean practices, maintain a collaborative work environment, and cultivate a no-blame culture conducive to learning. **Operational Principles readiness** ensures that the principles of streamlining workflows, minimizing waste, value maximization, and continuous improvement are the guiding principles of the project. **Tools readiness** verifies that the project can effectively utilize BIM for various applications, positioning it as a pivotal tool in project management. It also confirms that Lean tools will be employed consistently as part of the project's core operational strategy. **Dynamics readiness** emphasizes establishing flexible, multidisciplinary team structures that are ready to adapt to changing project needs. This readiness includes ensuring that team responsibilities are clearly defined and that teams are empowered with appropriate decision-making authority. **Engagement readiness** ensures that the project has developed comprehensive engagement strategies encouraging open and informal communication channels to keep all team members informed and aligned. As the final component to ensure operational framework excellence, the **Work Environment readiness** stresses the importance of conducting frequent Big Room meetings to promote inclusivity and sustained collaboration.

Readiness for Management and Oversight: This set prepares the project to implement management protocols that support effective execution and oversight. **Information Management readiness** verifies that the project is equipped to organize information in a structured and accessible manner, ensuring that information sharing is transparent and efficiently disseminated via digital platforms. **Financial Practices readiness** ensures that all team members are integrated into financial discussions, promoting a culture of shared financial responsibility. This includes the readiness to maintain financial transparency through open-book accounting and employ incentive mechanisms that enhance performance and sustain collaboration. **Risk Practices readiness** prepares the project to engage all members in risk management activities, ensuring a collective approach to identifying, assessing, and mitigating risks. In addition, it stresses utilizing collaborative tools like risk registers in the process. **Performance Monitoring readiness** confirms that the project can implement dashboards for the visualization of a broad range of performance metrics. The criticality of standardized data collection across all disciplines to enhance the accuracy and reliability of performance analysis is highlighted.

Readiness for Continuous Learning: The set ensures the project is prepared to adapt to evolving standards and stakeholder expectations through proactive learning and feedback mechanisms. This involves systematic capture and documentation of lessons learned, regular analysis of feedback about IPD practices, and continuous assessment of client satisfaction. This would foster a culture that embraces continuous improvement and responsiveness to feedback.

4.5.3 IPD Readiness Assessment Tool (IPD-ReAT)

At this stage, the Readiness Framework was transformed into a practical assessment tool called the IPD Readiness Assessment Tool (IPD-ReAT). Structured as a self-assessment tool in a questionnaire style, the IPD-RAT uses a binary (Yes/No) response format to simplify the evaluation process, supplemented by an 'I don't know' option to acknowledge uncertainties. Each readiness indicator developed in the previous steps is transformed into one or more questions, allowing for a direct assessment of readiness across various aspects of IPD.

The questions are designed to measure the extent to which project-specific readiness factors—outlined as readiness checkpoints—are present and actionable within the project plans. Each response is linked to a scoring system that calculates the average readiness score for each capability on a five-point scale and, based on it, categorizes the readiness into five distinct levels: Emergent, Low, Moderate, High, and Optimal. The readiness levels and scoring ranges are defined as follows:

- **Emergent** (0 to 1.0): Indicates a critical lack of preparedness with no actionable plans or strategies in place.
- **Low** (1.1 to 2.0): Suggests initial efforts in readiness with basic plans and strategies beginning to take shape.
- **Moderate** (2.1 to 3.0): Reflects a more developed state of readiness with structured plans, though not all areas may be fully addressed.
- **High** (3.1 to 4.0): Shows a high level of readiness with comprehensive and detailed strategies that cover many aspects necessary for successful IPD implementation.
- **Optimal** (4.1 to 5.0): Represents an ideal state where most of the readiness aspects are fully addressed with detailed and actionable strategies that ensure the project's success.

The readiness levels are calculated by aggregating the scores from each question, providing a quantifiable measure of readiness that can be analyzed at both the capability and overall project level. This enables a better understanding of which areas may require additional focus or more resources to enhance project readiness. This design ensures that the tool can serve as both a diagnostic and guidance tool that guides project teams toward targeted improvements in their readiness for IPD implementation.

In a final step, this tool involved an application and validation step through two case studies, as outlined in the next section, to ensure its effectiveness in assessing readiness for IPD projects.

4.5.4 Application and Validation

To validate and apply the developed readiness assessment tool, two case studies were conducted on IPD projects from two public bodies in the early stages of implementing IPD. The first case study evaluated the readiness for mechanical systems upgrade project for a commercial building, while the second is an educational building project, both in Montreal, Quebec.

The tool is designed to be used at the project level to evaluate the collective readiness of the entire project to implement IPD. For validation purposes at this stage, the owner representatives responded to the assessment on behalf of their teams. In follow-up meetings, we discussed how the tool should ideally be administered in practice to ensure it accurately captures the readiness of the full project team. It is intended to assess the collective capability of the project and the team as a whole, rather than evaluating readiness at the level of individual roles or subgroups. The focus is on how the project, in its integrated form, is positioned to implement IPD.

Table 4.3 summarizes the readiness levels across key capabilities for both case studies, based on self-assessments completed by the owner representatives involved in each project. This comparison highlights the tool's ability to deliver a precise and detailed picture of readiness for each project, pinpointing readiness strengths and weaknesses to facilitate targeted interventions.

Table 4.3 Readiness Assessment Comparison – Two Case Studies

Capability Sets	#	Capabilities	Readiness Level Case Study 1	Readiness Level Case Study 2
Understanding and Facilitation	1.1	IPD Comprehension	Low	Optimal
	1.2	Facilitation	Optimal	High
	1.3	Building and Sustaining Teams	High	Moderate
Goal Setting and Contract Development	2.1	Developing Project Goals (Validation Process)	High	High
	2.2	Defining project values	Moderate	High
	2.3	Contract Formulation	Low	Low
Project Governance	3.1	Defining Roles and Responsibilities	Low	Emergent
	3.2	Establishing Decision-Making Process	Moderate	Emergent
	3.3	Establishing Management Structure	Low	Moderate
	3.4	Owner involvement	High	Optimal
Operational Excellence	4.1	Operational Culture	High	High
	4.2	Operational Principles	Moderate	Moderate
	4.3	Tools	Low	Moderate
	4.4	Dynamics	Low	Low
	4.5	Engagement	Emergent	Low
	4.6	Work Environment	High	High
Management and Oversight	5.1	Information Management	Low	Low
	5.2	Financial Practices	Optimal	Low
	5.3	Risk Practices	Optimal	Low
	5.4	Performance Monitoring	Low	Emergent
Continuous Learning	6.1	Continuous Learning and Improvement	High	Moderate

The readiness assessment for Case Study 1 showed mixed results across different capabilities. The project demonstrated strong readiness in areas like Facilitation, Owner Involvement, Continuous Learning and Improvement, Building and Sustaining Teams, Developing Project

Goals, Operational Culture, and Work Environment. However, it faced significant challenges, with low readiness observed in IPD Comprehension, Contract Formulation, Defining Roles and Responsibilities, Establishing Management Structure, Tools, Dynamics, Information Management, Performance Monitoring, and Engagement, indicating a need for stronger efforts and interventions to fully prepare the project to embark on these areas.

In Case Study 2, the project demonstrated optimal readiness in IPD Comprehension and Owner Involvement, while high readiness was observed in Facilitation, Developing Project Goals, Defining Project Values, Operational Culture, and Work Environment. However, necessary attention to the readiness of the governance and monitoring aspects was highlighted by the emergent scores in readiness for Defining Roles and Responsibilities, Establishing Decision-Making Processes, and Performance Monitoring scoring emergent.

Following the assessment and the report preparation, follow-up sessions with six representatives from the two case studies were conducted in three meetings to further validate the assessment outcomes. These sessions involved semi-structured interviews and open discussions to gather feedback on the accuracy, clarity, and practical utility of the tool. Participants included owner-side project management team members responsible for initiating or coordinating the IPD implementation process. The feedback underscored the tool's practical utility and accuracy. As one participant remarked, “It was pretty effective… it really reflected what we were experiencing right now.” Another added, “This really shows where we stand.” Such feedback affirmed the tool’s capability to reflect the projects’ readiness status.

The sessions also led to critical refinements in the tool’s design. Developed in both English and French, the tool benefited from improvements to its wording and question formats, ensuring clarity and precision in both versions. Additionally, discussions highlighted the importance of defining the tool's administration process. The discussions led to two proposed approaches: The first approach is an audit, which involves having an evaluator administer the tool and complete the assessment. This process includes meeting the necessary individuals, collecting relevant data or information to support the evaluation, and reviewing project plans and documents to provide an informed response and ensure the accuracy of the readiness tool's outcomes. The second approach is gathering responses from a broader group, such as all IPD signatories, to minimize subjectivity and enhance accuracy.

A significant refinement involved the scoring system. Initially, "I don't know" responses were treated as equivalent to "No," which negatively impacted readiness scores. Discussions clarified that "I don't know" should instead be excluded from the scoring process. For example, if one respondent answered "Yes" and another "I don't know," the "Yes" response would suffice as evidence of readiness. This adjustment ensures that readiness levels better reflect reality and avoid penalizing projects for lack of specific knowledge among individual respondents.

This validation and application process demonstrated the readiness tool's relevance, applicability, and usefulness. The refinements made during this process enhance its usability and accuracy, setting the stage for its broader application across diverse IPD projects.

4.6 Discussion

Complementing the IPD Maturity Model developed by (Arar et al., 2025), which focuses on evaluating the maturity of IPD practices post-project and facilitating continuous improvement, the readiness model focuses on preparing projects to start IPD implementation. This study leverages the IPD capability framework by adopting its IPD capabilities and indicators. The essence of readiness was ensured by carefully examining the capability indicators and adopting only those suitable for readiness. This approach preserved the readiness model's ability to signal readiness while clearly differentiating it from the capability maturity model. The readiness model provides a detailed framework that outlines the readiness focus areas and a structured evaluation tool. This tool bridges the gap between abstract theoretical constructs and their practical application and offers a structured approach that operationalizes key dimensions of readiness in actionable terms.

Previous research efforts in IPD readiness, such as the models developed by Azhar (2014) focusing on IPD and Information and Communication Technology (ICT) readiness and the organizational readiness within Malaysia's Industrialised Building System (IBS) as explored by Osman et al. 2015, 2017), provide valuable insights that context of alignment and preparedness conditions for IPD adoption and implementation. However, these studies either addressed the alignment of projects with broad IPD principles or assessed organizational readiness to adopt IPD, lacking a focused approach to the specific readiness needs of projects at their initiation stages to start implementing IPD. This study builds on and diverges from these models by offering a readiness framework and assessment tool that evaluates project-specific conditions rather than overarching organizational readiness.

Furthermore, while the IPD and ICT readiness model by Azhar (2014) assesses alignment with IPD principles mainly through the lens of technology integration, the readiness model presented in this study extends this by incorporating human and structural dimensions in addition to the technological dimension. The readiness model evaluates human readiness elements that gauge the project team's willingness and confidence to engage in IPD, such as their comprehension of IPD, the training and facilitation, the team building, and team culture and engagement readiness, emphasizing the importance of fostering an environment essential for the success of IPD projects. Structurally, the readiness model integrates assessments of governance and management structures, such as the owner involvement, role definitions, project management structure, and decision-making process to ensure the project is ready for IPD in terms of project management frameworks. Additionally, it considers the technological dimension as part of the tools readiness that focuses on integrating BIM as well as important operational methodologies such as Lean tools and practices, which are critical for operational excellence in IPD.

From a different angle, the readiness model theoretical grounding draws on organizational readiness for change principles, which emphasizes the multilevel and multidimensional nature of readiness. These principles delineate readiness as not merely a static state but a dynamic construct involving psychological and structural preparedness across change commitment and change efficacy. Therefore, readiness should concern both the willingness to adopt change and the capacity to implement it effectively (Holt et al., 2007; Weiner, 2020). For instance, in the second case study, while project teams exhibited an optimal comprehension and commitment to IPD principles, the gaps in governance-related capabilities, evidenced by an emergent readiness in defining roles and responsibilities and decision-making processes, would undermine their efficacy in implementing these principles. Accordingly, this study positions readiness as an early-stage preparedness that focuses on the capability of projects to implement IPD. This positioning is achieved by incorporating these theoretical constructs in practical readiness indicators and checkpoints that reflect the technological, psychological, and structural arrangements required to initiate collaborative and integrated practices.

Although the model focuses on project-level readiness, its structure underscores the multilevel nature of readiness, as emphasized in organizational change theories (Holt et al., 2007; Juan et al., 2017; Britel & Cherkaoui, 2021), where readiness for different capabilities requires alignment at the organizational, project, and individual levels. Project-level readiness, in the context of IPD, is inherently multi-organizational, requiring coordination and alignment across all IPD signatory organizations. The model addresses this by evaluating the collective readiness of both the integrated project and its team, with readiness indicators designed to reflect shared responsibilities, joint planning, and interdependent capabilities that span organizational boundaries. For instance, capabilities such as “IPD Comprehension” and “Building and Sustaining Teams” directly address the knowledge, attitudes, and behaviors critical for fostering individual readiness within the broader project framework. Similarly, the readiness model incorporates organizational aspects by embedding elements that touch on organizational readiness and alignment. For example, capabilities like “Owner Involvement” and “Establishing Management Structures” highlight how organizational frameworks and leadership influence readiness. These aspects illustrate how the readiness model can incorporate readiness elements across multiple levels, ensuring alignment for effective IPD implementation.

That being said, the model does not explicitly address organizational-level readiness for IPD adoption. Organizational readiness involves strategic alignment, cultural transformation, governance structures, and overarching strategic goals that extend beyond the scope of project-specific readiness (Magalhães et al., 2023).

Building on this theoretical foundation, the model’s validation through case studies provides further practical insights into its utility and implications. The results demonstrated that the readiness model effectively identifies strengths and areas for improvement within projects, providing detailed readiness profiles. For instance, while the results highlighted high to optimal readiness in facilitation and owner involvement in Case Study 1, they also indicated challenges in governance and operational readiness, such as in defining roles and responsibilities and engagement. These applications reinforce the model’s applicability in diagnosing specific readiness gaps that may hinder IPD success. On the other hand, the validation revealed that the tool has certain limitations. For some of the indicators, additional exercises or evaluations are needed to get proper answers. For instance, in the case of assessing the team's knowledge of IPD principles, surveys or other forms of evaluation may be required. While the tool itself does not delve into such granular assessments, it provides a framework that the project teams or evaluators can use to guide these supplementary activities.

4.7 Conclusion

The Readiness Model developed in this study addresses a notable gap in the current state of IPD adoption and implementation by providing a detailed readiness framework and a structured tool to assess and guide readiness for IPD implementation at the project's early stages. The model offers a unique contribution by operationalizing readiness assessment through specific, actionable readiness checkpoints, aligning and streamlining efforts to guide project teams through areas required for successful IPD implementation, ultimately facilitating more standardized and consistent IPD implementation.

The deliverables of this research included the development of the IPD Readiness Model, comprising two interrelated components, namely: 1) the IPD readiness framework that organizes essential IPD capabilities and related readiness indicators into actionable focus areas, offering a comprehensive structure to guide project planning and alignment; and 2) the IPD Readiness Assessment Tool, IPD-ReAT, to provide structured evaluations and readiness scoring. Validation through two case studies confirmed the model's practicality and relevance, highlighting its ability to pinpoint readiness strengths and gaps, and offering insights for improvement.

By grounding the IPD Readiness Model in both the IPD capability framework, which is established upon empirical data from real IPD projects, and in principles of organizational readiness for change while tailoring its application to project-specific readiness, this study bridges practical and theoretical insights with actionable tools, setting the stage for more structured and consistent implementation of IPD.

On the other hand, the study approach encountered a few limitations. For instance, the basis of validation was done with only two projects that were in the early stages of implementation where the project teams had not yet been fully assembled. As a result, the IPD readiness tool was primarily used by the owner teams dedicated to IPD rather than the entire IPD project team members. Ideally, the tool would be applied to a whole assembled IPD team to yield a complete perspective on the state of the project's preparedness to start implementing IPD collaboratively. Future studies should overcome these limitations by validating the model and the tool on a larger number of projects from diverse domains and by embedding a broader validation process engaging the participation of entire IPD teams at the inception of their collaboration.

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CHAPTER 5

DISCUSSION

5.1 Introduction

This chapter presents an overreaching discussion of the research approach and findings. It examines the steps undertaken in developing specific artifacts and discusses the collective outcomes of the entire research, aiming to underscore the interdependencies among the various phases, leading to a deeper understanding of the research presented in this dissertation.

5.2 Research Approach Discussion

This research leverages a staged development research design guided by DSR principles to develop and refine a set of artifacts and frameworks aimed at advancing the effectiveness of IPD implementation by enabling informed evaluation of its practices and facilitating a path for continuous improvement. Adopting DSR as a methodological framework was underpinned by a pragmatic philosophical stance that framed the epistemological and ontological perspectives guiding this research (vom Brocke & Maedche, 2019; Morgan, 2014). Embracing these philosophies laid the ground for a dynamic and iterative development process, emphasizing the practical benefits and the application of research findings in real-world settings. This is particularly true for IPD as a novel and evolving approach that still lacks many essential pieces in its theoretical framework and practical applications. Therefore, this stance was reflected in the development process presented in this research, which was accomplished through staged progress and iterative development and validation of practical artifacts that can enhance IPD implementation. This aim was prioritized over theoretical abstraction, focusing instead on generating actionable insights that are immediately applicable and beneficial in enhancing the practices of IPD.

Epistemologically, as this research focuses on practical outcomes and evaluates theories based on their usefulness and practical impact rather than philosophical debates, its approach centered around the question: "What real-world problems can be solved by the knowledge being developed in this study?" The answer was enhancing IPD implementation and facilitating continuous improvement of its practices (Kaushik & Walsh, 2019; Morgan, 2014). Therefore, the knowledge developed in this research is viewed as a tool for solving this practical problem. Consequently, the validation of the knowledge, specifically the IPD maturity and readiness tools, was judged by their utility and effectiveness in application. In addition, the same perspective was reflected in the research methods, which were chosen flexibly based on their capability to answer the research question and drive practical outcomes. This stance can be noticed in the diverse methodological approaches and mixed-method strategy employed throughout the different stages of this research. Data collection was multifaceted, involving case studies, interviews, surveys, and engagement with industry practitioners, supplemented by evaluation sessions. Additionally, a systematic literature review was conducted to broaden the theoretical base. These data were analyzed using a range of methodologies, including systematic combining, framework synthesis, and thematic analysis, ultimately facilitating the achievement of the project's objectives.

Ontologically, the pragmatism approach does not commit to a single perspective of reality, which can independently exist and be socially constructed, depending on the context. The focus here is on engaging with reality to develop practical, useful knowledge (Kaushik & Walsh, 2019; Morgan, 2014). Therefore, this research assumes that the realities of project delivery systems like IPD can be pragmatically understood, whether through objective data provided by quantitative methods or subjective and socially constructed data provided by qualitative methods. Thus, the pragmatic philosophy directs the methodological choices in this research toward a mixed-method approach that focuses on outcomes that can enhance IPD implementation and efficiency.

This pragmatic stance is operationalized through incorporating DSR as the methodological framework and focusing on developing and evaluating the maturity and readiness models and tools. Adopting the DSR framework empowered this research to embark on a systematic investigation into the IPD and deliver solutions that are theoretically informed and validated through practical application. Therefore, as detailed in **section 1.7**, the methodological steps taken in this research adhered to DSR principles and guidelines, starting with problem identification to leveraging the existing knowledge, then developing the artifact, followed by the application and validation phase that leads to refining the tools and finally communicating it to the industry (Hevner & Chatterjee, 2010; Venable et al., 2012; vom Brocke et al., 2020; vom Brocke & Maedche, 2019).

5.3 Research Findings and Contributions Discussion

The findings of this research and their discussion are detailed in Chapters 2, 3, and 4. However, in this section, those findings are discussed from the perspective of their contribution to fulfilling the overall objective of this research, which involves developing and validating practical artifacts that enable an informed evaluation of IPD practices and facilitate continuous improvement. The research findings represent a step toward more empirical and data-driven decisions and strategies regarding IPD implementation and improvement of its practices, which is critical in informing evolution from isolated implementation strategies to a more standardized and consistent approach (Roy et al., 2005; Gibb & Isack, 2001). Together, the three interlinked outcomes of this research, namely the R&D framework, the capability maturity model, and the readiness model, advance this empirical agenda by addressing specific gaps in prior IPD literature, offering new frameworks and tools that redefine how IPD implementation is evaluated and improved.

In the first paper presented in Chapters 2, the R&D framework enhances the theoretical landscape by providing a structured map that links existing research to the practical phases of IPD and highlights underexplored areas. While prior studies have noted the growing academic interest in IPD (Kahvandi et al., 2017; Rashed & Mutis, 2021; Viana et al., 2020), they have lacked a mechanism to coordinate research efforts with real-world implementation. This framework addresses that gap by synthesizing thematic gaps identified in the literature and validating them through insights from IPD case studies. In doing so, the dialogue in this research represents a shift in narrative from solely theoretical contribution to a balance of theoretical grounding and actionable findings, bridging theory with practice and setting it apart from earlier efforts.

In the second paper presented in Chapters 3, the IPDCMM fills a critical gap in the IPD literature by introducing a maturity model specifically designed for the post-project phase at the project level. While existing frameworks incorporate core IPD principles (AIA, 2007, Ashcraft, 2012, Cheng & Johnson, 2016, Fischer et al., 2017, Allison et al., 2018, Poirier et al., 2022), the IPDCMM extends this body of work by embedding 112 empirically derived indicators, enabling a detailed and structured evaluation of IPD practices. Although the model aligns conceptually with maturity models from other domains such as BIM, Lean, and project management (L. A. Initiative, 2001; Kwak & Ibbs, 2002; NIBS, 2007) many of those models emphasize organizational-level assessment and are often criticized for lacking strong empirical foundations (Lasrado et al., 2015; Normann Andersen et al., 2020). In contrast, the IPDCMM is project-specific and grounded in extensive data from three diverse IPD case studies, offering a validated assessment tool that supports informed evaluation and continuous improvement of IPD implementation.

In the third paper presented in Chapter 4, the IPD Readiness Model addresses a major gap in the literature by focusing on project-level conditions required at the initiation phase to implement IPD effectively. While earlier models, such as Azhar, (2014) IPD-ICT readiness model and the organizational readiness assessments by Osman et al., (2015, 2017), offered important insights into broader alignment or technological preparedness, they lacked a structured approach tailored to the specific readiness needs of individual projects. This model builds on and diverges from prior efforts by operationalizing readiness across human, structural, and technological dimensions through a detailed framework and practical evaluation tool. Drawing from organizational change theory (Holt et al., 2007; Weiner, 2020), readiness is framed as a dynamic, multilevel construct involving both commitment and capacity to change. The model translates these concepts into project-specific indicators that assess psychological readiness, governance structures, team capabilities, and tools integration. Validated through two IPD case studies, the model demonstrates its ability to diagnose readiness gaps at the project outset and guide interventions, offering both theoretical grounding and practical utility for supporting IPD implementation.

Having stated the contributions of each paper within the broader IPD literature, the remainder of this discussion reflects on how these contributions align with the Design Science Research methodology outlined in **section 1.7**.

Understanding the Issue/Problem Identification: The initial phase of problem identification and understanding the issue is detailed in Chapter 2 of the thesis. A systematic investigation into the IPD research domain led to the development of the Research and Development framework for IPD. This was crucial for establishing a solid understanding of the different aspects of this approach and identifying theoretical and practical gaps in its application. This framework exceeded the identification purpose and prioritized areas where academic contributions can most effectively support practical needs, thereby enhancing the relevance and applicability of IPD research. This outcome was particularly relevant to the IPD field, considering the critical disconnect between theoretical advancements and practical implementations within the industry discovered at this step. Additionally, this step aided in identifying the established pieces of knowledge around IPD that were leveraged in the remainder of this research and extended a foundation to develop the models and the artifacts.

Leveraging Existing Knowledge: The findings of the three phases of this research were all built upon and incorporated existing theoretical frameworks and empirical data around IPD. In particular, the R&D framework for IPD, presented in Chapter 2, included a systematic combination of established IPD frameworks and empirical data from three case studies to develop the R&D framework. For instance, the IPD Capability Maturity Model introduced in Chapter 3 synthesizes insights from maturity models in fields such as BIM, Lean, and project management. This model integrates these insights with established IPD frameworks, enhancing it with empirical data from the case studies. This approach resulted in the development of a capability framework for IPD and the associated maturity matrix. These components were instrumental in creating the IPD Maturity Assessment Tool, which enables a structured evaluation of IPD practices' maturity levels. Similarly, the Capability Readiness Model, presented in Chapter 4, leveraged the capability framework presented in Chapter 3 and expanded upon it to develop the Readiness Model and tool for IPD.

Development of Artifacts: The phase of developing the artifacts can be seen in Chapters 3 and 4. Each artifact was designed to solve specific problems identified in current IPD practices, namely, the lack of structured tools that can enable informed evaluation and continuous improvement of IPD practices after project completion (maturity assessment) and the lack of tools that can assess and guide the efforts of ensuring that projects are ready to start implementing IPD (readiness assessment). These artifacts, in addition to being a valuable addition to the IPD project toolkit, could serve as strategic tools that enable organizations to make educated decisions about their IPD implementation and develop informed, long-term strategies to enhance their practices.

Application, Validation, and Refinement: Following the development of the artifacts, their application in real-world settings was accomplished to test the theoretical assumptions underpinning these artifacts, validate their relevance and practicality, and gather feedback to help refine them. This step is illustrated in both Chapters 3 and 4. In Chapter 3, the maturity assessment tool was applied to two projects from the three case studies used to build the model. For these two cases, evaluation sessions were conducted using the tool, followed by preparing a detailed maturity report for each case and then interviews with key representatives from each project to discuss the findings, outcomes of the maturity assessment, and the tool's relevance and applicability. Similarly, in Chapter 4, the readiness assessment tool was applied to another two case studies, following the same procedure of conducting an evaluation session, preparing a detailed readiness assessment report, and followed by interviews with key representatives from the two projects to help validate and refine the tool.

Communication and Industry Feedback: Finally, the research findings, particularly the maturity and readiness tools, began to be communicated to both academic and industry stakeholders to enrich the dialogue around these tools in particular and IPD practices in general. This included presenting the tools at avenues like the "Innover Ensemble" symposium and discussing them with different industry stakeholders with plans for wider diffusion in the future.

5.4 Theoretical Foundations Discussion

The research positioned IPD within three complementary theoretical lenses, each offering a distinct way to understand how IPD functions as a collaborative delivery model and served as conceptual anchors throughout the research design. The findings and artifacts developed in this dissertation provide both conceptual and empirical support for Systems Theory, Relational Contract Theory, and Collaboration Theory, while also expanding their relevance to the construction domain, particularly in collaborative project delivery and IPD.

Systems Theory sees organizations and projects as interconnected parts where success depends on the whole system and its interdependence (Bertelsen, 2003; Hoorn et al., 2019). The findings of this dissertation strongly reflect these principles. The development of the IPD Capability Framework demonstrated that IPD cannot be understood through isolated practices; instead, it operates as an integrated configuration of capabilities that enable the effective implementation of IPD as an integrated system. The Capability Maturity Model and Readiness Model further operationalize these systemic characteristics: both models emphasize the need for alignment between organizational, contractual, technical, and behavioral elements. Further, while the case studies were not designed to analyze these system dynamics directly, their use in validating the framework and artifacts highlighted the need to maintain coherence across these interrelated elements, which aligns with a systems-oriented interpretation of IPD.

Relational Contract Theory highlights the importance of trust-based relationships, reciprocity, fairness, and shared norms in governing long-term collaborations (Feinman, 1999; Macneil, 1999). These principles offer a conceptual foundation for understanding how IPD structures its contractual and behavioral environment. In this dissertation, the development of the IPD Capability Framework drew on relational-contract concepts to articulate why IPD depends on mechanisms such as shared risk and reward, transparent financial arrangements such as open book, and joint governance. These relational elements informed the structuring of several readiness and maturity indicators, particularly those related to alignment of expectations, clarity of roles, trust-building practices, and inclusion in decision-making. While the case studies were not designed to examine relational norms directly or to assess their influence on project performance, their use in validating the framework and models underscored the practical relevance of relational-contract concepts in shaping the conditions required for coherent IPD practice.

Collaboration Theory emphasizes shared goals, open communication, information exchange, collective problem-solving, and interdependence among team members (Moradi & Klakegg, 2024; Schöttle et al., 2014; Shelbourn et al., 2007). These principles provide a conceptual foundation for understanding the behavioral and interpersonal dynamics required in IPD. In this dissertation, Collaboration Theory informed the conceptual framing of the IPD Capability Framework and guided the identification of several readiness and maturity indicators that correspond directly to collaborative practices. For example, indicators related to open communication, encouragement of participation, and the establishment of team culture reflect collaboration theory's emphasis on interpersonal dynamics within the "Building and Sustaining Teams" capability. Similarly, indicators such as collaboration in the validation process, joint development of project goals, and continuous revisitation of project values align with the theory's focus on shared objectives and alignment.

While the case studies were not designed to empirically assess collaborative behavior, they informed the development of the collaboration-related indicators in the capability framework. Observations from the projects guided the identification and consolidation of elements linked to communication, effective participation, shared goals, and joint decision-making. In this context, Collaboration Theory provided the conceptual lens through which these observations were organized, allowing the resulting indicators to reflect the collaborative dynamics that support the integrated IPD practice. These indicators later contributed to the development of the maturity and readiness models, providing a structured way to evaluate and enhance these elements and offering a practical contribution to the theoretical understanding of collaboration in project delivery.

5.5 Research Originality

The originality of this research is anchored in its contributions to the IPD literature that address two interrelated gaps: the absence of a cohesive framework to structure IPD research and development, and the lack of structured tools to assess and guide IPD implementation across the project lifecycle. To address these gaps, this study introduces the first IPD Research and Development Framework, which offers a structured means to organize fragmented knowledge and link theoretical constructs with industry practices. Unlike prior efforts that emphasize either theoretical or practical aspects of IPD, this framework identifies and organizes the constituent parts of IPD in a structure that reflects how IPD is actually implemented in practice, making it both theoretically robust and practically familiar. In doing so, it supports a more unified approach to IPD research while providing a roadmap for strategic development and improvement.

Building on this foundation, the research also presents two novel models: the IPD Capability Maturity Model and the IPD Readiness Model. These contributions are original in both intent and design, as the IPD literature includes no prior work that formalizes these concepts into usable, validated instruments. These models and their associated tools enable project teams and researchers to evaluate implementation quality, benchmark IPD capabilities, and support data-driven learning and continuous improvement. Moreover, they allow for comparative analysis across projects, thereby facilitating the formalization of knowledge about how IPD is adopted, evolves, and performs under various conditions.

The credibility and generalizability of these contributions are grounded in a rigorous validation process and supported by diverse real-world data drawn from five Canadian IPD case studies. Some of these projects were deeply investigated, producing detailed datasets that informed model development; others were specifically engaged to facilitate iterative validation. The value of this approach is reflected in the direct interaction and knowledge exchange between the researcher and industry practitioners through case study research, assessment sessions, and validation interviews. This ensured that all deliverables are both theoretically sound and practically relevant, reflecting actual implementation challenges and conditions.

In addition, the models and framework were grounded in a strong theoretical foundation, developed through a thorough synthesis of the IPD literature and the integration of existing frameworks. This dual grounding, in theory and practice, enhances both the originality and applicability of the research, positioning it to support future scholarly inquiry while delivering actionable value to industry.

CONCLUSION

Through the investigation of IPD and the development of means to evaluate its practices and facilitate continuous improvement, the research undertaken in this dissertation provided an opportunity to engage with the deeper complexities of collaboration and innovation in the construction industry. Interaction with empirical data, engagement with industry practice, and iterative model development revealed the evolving nature of IPD, not merely as a collaborative project delivery approach, but as a shifting paradigm that demands cultural adaptation, organizational learning, and sustained commitment. This exploration represents an initial step toward understanding and advancing IPD and toward enabling a path for its further development. Within this research journey, both the theoretical constructs and practical dimensions of IPD were examined in an effort to answer the following questions: "What are the key characteristics of IPD? How can these characteristics be articulated to organize the research and development domain? How can this articulation enable informed evaluation, consistent implementation, and continuous improvement of IPD?"

This fundamental shift was carefully explored through the development of the IPD R&D Framework. This framework, informed by an extensive literature review and empirical data from case studies, has identified the constituted parts of IPD, organized the research and development domain, and highlighted the uncharted areas of IPD practice. By doing so, this research answered the first part of the research question about clarifying the essential characteristics of IPD and demonstrating how they interconnect to reform the research and development landscape. This theoretical exploration extends beyond representing a foundation phase for this research to further serve as a critical platform that shapes the ongoing dialogue about the systemic, relational, and collaborative dynamics of IPD, offering a pathway for future research.

From this foundational framework, the research progressed to the creation of two key artifacts: the IPD Maturity Assessment Tool (IPD-MAT) and the IPD Readiness Assessment Tool (IPD-ReAT). These tools were designed to assess and enhance the maturity and readiness of IPD practices, respectively. They provide empirical means to evaluate how well projects are prepared to implement IPD and to what extent they effectively implement IPD practices. This aspect of the research answered the later part of the research question regarding enabling informed evaluation, consistent implementation, and continuous improvement of this innovative approach.

The border implications of these tools, although centered on the project level, extend beyond individual projects, providing a framework for organizations to build maturity in their IPD practices over time. The readiness and maturity assessment of IPD practices can reveal underlying weaknesses and highlight strengths in a structured manner. This should help organizations and industry practitioners better understand the context and performance of their IPD projects, thereby enhancing their ability to measure and systematically improve their IPD capabilities.

Additionally, advancing IPD's effectiveness through this research could have implications that extend beyond the immediate benefits of project outcomes. Strengthening IPD's theoretical framework and enhancing its applicability through the development of readiness and maturity tools contributes to solidifying IPD's foundation. As IPD becomes more theoretically robust and practically viable, its adoption is likely to increase, fostering a systemic change in the industry toward a more sustainable and collaborative future.

However, the study's scope and findings are determined by the contexts from which the data were gathered. In this regard, a key limitation of this research is the small number of case studies, all of which are based in Canada and belong to the public sector. As a result, further testing and validation are needed to assess the broader applicability of the findings across different geographic locations, project types, and sectors.

In looking forward, this research lays the groundwork for multiple lines of inquiry that could advance both the theory and practice of IPD. One such avenue involves exploring the scalability of the developed models within different project settings, sectors, and geographical areas where collaborative project delivery could yield significant benefits. Further, future work could explore the correlation between maturity scores and project outcomes, looking for potential correlations between scoring high on the maturity tool and achieving enhanced project outcomes. Similarly, a correlation between the readiness score, project outcomes, and effective IPD implementation could be investigated. This should establish empirical evidence regarding the tool's applications and effectiveness.

Since this research does not consider the Organizational-wide-ranging influences, further research should be specifically designed to consider how such a structured evaluation approach introduced in the maturity and readiness tools at the project level might influence broader organizational practices and test the potential benefits of IPD Capability Maturity and Readiness Models applications at organizational levels. Lastly, while the Capability Maturity Model and Capability Readiness Model provide critical frameworks for post-project evaluation and pre-project planning, a missing piece remains: the capacity to evaluate IPD practices during project execution. Such a model should offer a systematic approach to monitor and assess IPD practices throughout the execution phase, providing real-time insights and ensuring alignment with IPD principles.

Finally, as the construction industry continues to grapple with fragmentation, inefficiencies, and trust deficits, collaborative approaches like IPD, supported by empirically grounded tools, offer a promising path forward. The frameworks and tools introduced in this research are foundational yet remain open to refinement through further empirical validation and practical application. This work should be viewed as an initial step toward the development of a broader and evolving infrastructure to support the implementation of collaborative project delivery in general, and IPD in particular, ultimately contributing to ongoing efforts to shift the construction industry toward more integrated and collaborative practices. It is hoped that the contributions made in this dissertation will play a meaningful role in advancing that transformation.

ANNEX I

CONFERENCE PAPER: THE NEXT ERA OF IPD RESEARCH: A SYSTEMATIC LITERATURE REVIEW OF IPD RESEARCH TRENDS 2017-2020

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Abstract

Questions around integration, innovation, and collaboration within project teams have been the focus of increasing research in recent years. This is in response to the notorious fragmentation and the inherent performance issues that face the construction industry. Among the solutions identified, new contractual approaches, namely, integrated project delivery (IPD), have been investigated to understand how they can help overcome the industry's issues. This paper aims to contribute to the previous efforts that studied the research trends of the IPD from 2001 to 2016 by synthesizing the last four years from 2017 to 2020. This period accounts for more than 70% of research on IPD compared to the previous 16 years combined. A systematic literature review was conducted to understand the trends in IPD research over the last four years. The results allowed the research team to understand better where such research was being conducted, what type of projects were being studied, and most importantly, the topics being covered within this research and its results. This paper proposes an initial review that will be further developed in a full-length journal paper.

Introduction

The past two decades have seen the emergence of integrated project delivery (IPD) as an alternative to traditional project delivery approaches. IPD relies on bringing the key participants of a project into a multiparty contract where risks and rewards are shared, and the project is managed in a way that enables collaborative decision-making. This approach has emerged as highly effective instead of other, more traditional project delivery systems. It has demonstrated distinct advantages in directing the attention of project parties toward meeting a project's objectives.

Many studies have been conducted on this innovative and collaborative approach to enrich the collective understanding of the principles and promises of IPD while investigating the factors that affect its adoption since its emergence at the beginning of the 2000'S. Researchers have conducted some reviews to synthesize this knowledge, namely Kahvandi et al. [4], who investigated research between 2001 and 2016. As IPD grows in popularity, its investigation through research also intensifies. This paper summarizes findings from a systematic literature review that builds on Kahvandi et al.'s [4] work to investigate research conducted between 2017 and 2020. The aim is to identify and discuss the research trends of the past four years concerning IPD. A full-length follow-up paper will present the results of this investigation in depth.

Literature review

The construction industry has been described as a broken industry by many. Indeed, it has failed to take full advantage of the technological advances in many areas that serve the construction process such as, material science, building technology, and equipment, to name but a few. Low productivity levels were among the prominent leading indicators of this missed opportunity to maximize the value generated. The construction industry has systematically experienced a decline in productivity levels in stark contrast to other Non-farm industries [1].

It is widely believed that fragmentation between project parties is one of the main reasons for this situation [2]. This deprives project parties of getting the most out of their respective and collective capabilities. These missed opportunities include early involvement of critical knowledge and experience early in the design phase, ensuring alignment to project goals across the project team, and incentivizing collaboration throughout the project's lifecycle [3]. Therefore, a call for change in the way projects are managed, contracts are developed, and teams are formed has been heard around the globe.

IPD has been hailed as a solution to many of the industry's current issues. The beginning of research on IPD can be traced back to 2001, with its roots being tied to relational contracting strategies and approaches developed in the 1980s and 1990s. Since then, IPD has rapidly grown in popularity and has been the subject of much research. For instance, the authors of [4] Investigated the developments of IPD over 15 years and displayed the research trends of IPD from 2001 to 2016. The results of their research can be summarized as follows:

The USA leads in IPD from 2001 to 2016, taking advantage of the fact that most of the initiating studies on IPD were conducted there; however, IPD studies were conducted in many countries, including many developing countries.

The most significant percentage of the studies in the period in question used some sort of conceptual data of IPD more than quantitative and qualitative data.

Two different periods can be noticed; in the first, the most significant percentage of IPD research addressed the principles of IPD, while in the second, it investigated the challenges and barriers of IPD adoption. However, many studies that looked through other aspects of this promising delivery system, such as the integration between IPD and BIM, the implementation of IPD, and solutions to the barriers, were conducted.

In terms of the application domain, most IPD research has studied the application of IPD on infrastructure projects in that period.

Methodology

In the last four years, research on IPD has continued to grow. Researchers from different countries around the world have scrutinized the different aspects of this promising approach. This study builds on the previous efforts in [4] that studied the research trends of IPD from 2001 to 2016 by covering the period from 2017 to 2020. It synthesizes the research done on IPD to form and understand the current research trends and the gaps that still need more contribution. Moreover, this study tried to enhance some aspects of the previous study by following a rigorous review process and providing the details of the review process, including the inclusion and exclusion criteria, and reform some used categories and classifications to represent the research trends better.

This study applied a systematic literature review methodology to discover the research trends around IPD from 2017 to 2020. The intent behind choosing this methodology is to provide more reliable results through a rigorous process containing predetermined inclusion and exclusion criteria. In addition, to provide the full path of the review process [5], where the systematic literature review "is designed to reduce the effect of the reviewers' own bias, and a full protocol should be written to define and guide the process" [6]. Lastly, the extracted data from the systematic review were combined or compared in many places with the data from [4] to understand the evolution of IPD research trends over the last two decades.

Review process

The process started by searching specific academic databases such as (ASCE, EI Compendex, Inspec, Knovel, IEEE, Science Direct, Springer Link, Wiley online library, Emerald, and ASME), for articles that contain any of the two terms, integrated project delivery and IPD, in any part of the article. The inclusion criteria were set to include all papers about IPD within the construction industry, published between 01-01-2017 and 31-12-2020, published in peer-reviewed journals or conferences. The exclusion criteria were established to exclude all papers that fall under other types of documents, addressing industries other than Construction, Studies that we could not get access to its full paper., and papers in languages other than English.

The first round of the review process resulted in collecting 1044 papers carried forward to the next step of the research. Then, those papers were first sorted and filtered to remove all duplicated papers. This process left a total of 615 papers, which were then scanned by title and abstract to remove irrelevant papers. Next, papers that do not have open access and those in a language other than English were excluded. As a result, the final number of publications considered in this review was 112 articles, as shown in Figure A I.1.

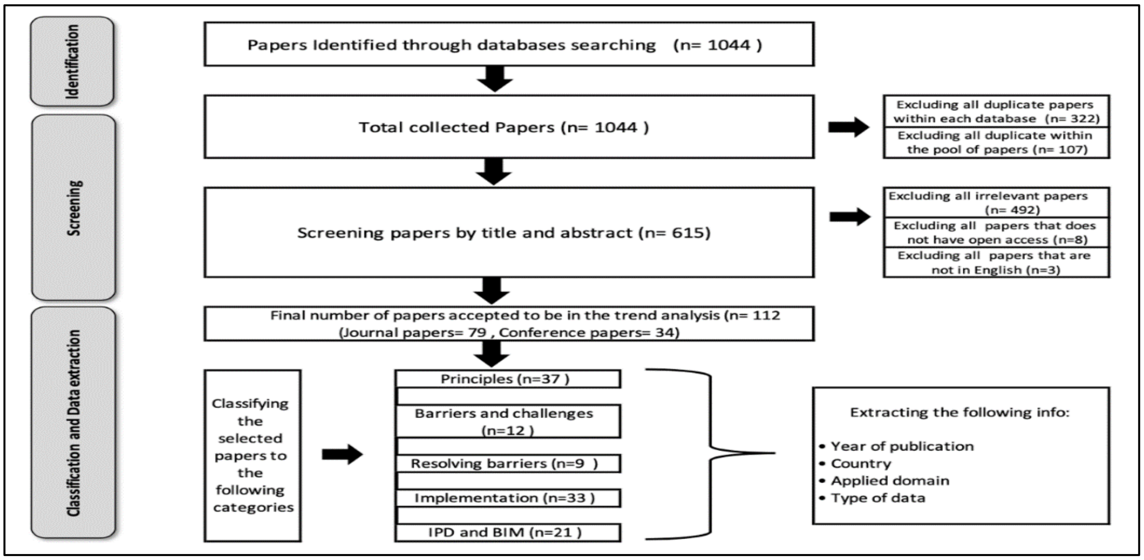

Figure A I.1 Flowchart of the review process

Validation

The review process and results were validated through two different stages; the first stage was to validate the review protocol and the review process, which was done through two specialist librarians at the École de technologies supérieure's library. The review protocol and a detailed research process were submitted to them for review. A meeting was held with them where the details of the process were discussed. As a result of this step, a revised version of the research protocol has been generated.

The second stage was used to validate the review results, which were done with the help of an external validator. This external validation process first explained the review protocol, review process, and the pool of papers to the researcher validating the approach. The person randomly selected 15% of the papers, extracted the required information, and classified the papers. The results from this round of validation process were compared with the researcher's results. The comparison revealed an 85% match of the data extracted. Next, the researcher added his explanation to the points of differences with the validator, and the sheet was sent back again to the validator for the second round of validation. Again, the validator responded to the researcher's arguments, and the percent of the match after this round reached 98%. Eventually, the logic concluded from this exercise on 15% of the articles was applied to all the other articles. In addition, the classification categories were reviewed by the validator, and a new application domain category was suggested that ensure better classification for the project types under each domain.

Data analysis and discussion

As illustrated in the previous section, the search process resulted in 112 papers, of which 78 were journaled papers and 34 were conference papers. These selected papers were read, and information on the publishing year, country of publishing, type of data used, the domain of application, and the subject area were extracted to form and understand the research trends around IPD research.

Publishing year

The first indicator developed was the year of publication. The year of publication was determined as the year the paper was made available, not the year of submission or approval. The results show that the last four years from 2017 to 2020 represent a continuation of the growing trend in IPD research, where the amount of the published research in the last for years equals more than 70% of the total published research in the period from 2001 to 2016. In particular. The year 2019 saw the highest number of IPD publications between the last four years with 32 papers, while both 2017 and 2018 have witnessed 30 and 29 publications respectively, while only 21 papers were published in 2020.

Country of publishing

Another aspect that was considered is the global reach of IPD research by identifying the country of publishing. In the cases where multiple authors with different affiliations were indicated, the first author's affiliation was used to determine the country of publication. The reviewed papers show that in the period from 2017-2020, 28 different countries have contributed to the efforts of investigating the different aspects of IPD. As shown in Figure A I.2, the USA, China, and Norway are leading in terms of the number of IPD research published in the period in question. The USA alone contributed to the diffusion of 31 research, while China diffused 22 research and Norway put in 9 research. Next in the list, UK and Canada arose with 5 and 4 research on IPD, respectively. It is interesting to note that Asia as a continent diffused 45 IPD research produced by 12 different countries. North America came next with 35 publications, then Europe with 26 research by ten different countries. In contrast, only two countries in Africa and one country in South America and Oceania have shown up on the list.

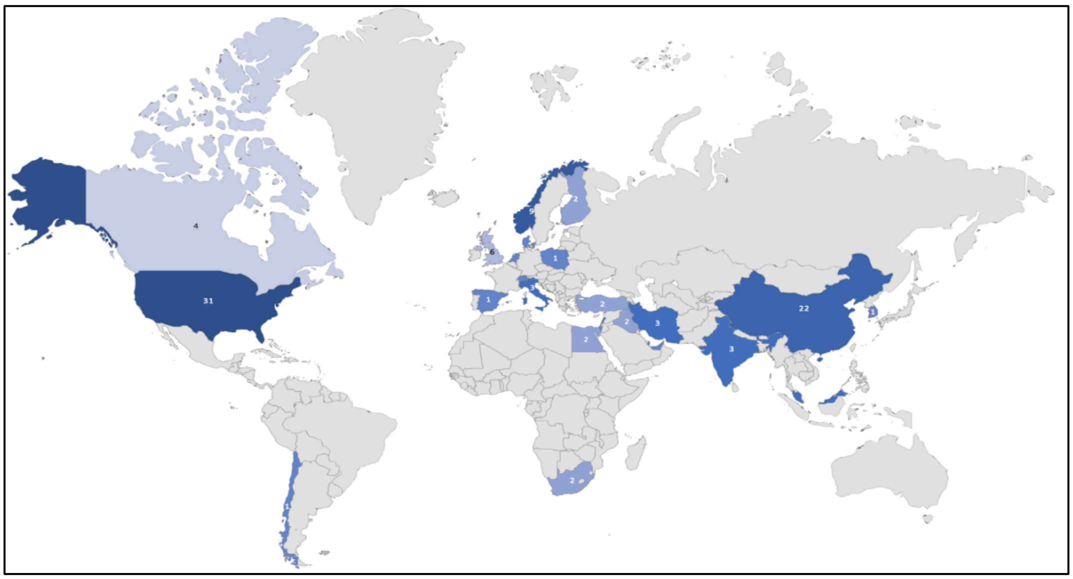

Figure A I.2 Distribution map of IPD research from 2017-2020

By looking back to the period from 2001 to 2016, remarkably, the result in [4] did not provide the total number of countries that diffused IPD research; instead, they mentioned that 13 countries and the European group have contributed to IPD research. Therefore, to be able to compare with that period, the 28 countries that diffused IPD research from 2017 to 2020 can be sorted in the same logic to 18 countries and the European group, and that is indicating the notable increase in the number of countries that are participating in the IPD research efforts.

Type of research conducted

As indicated by the data collected and used to analyze and interpret the results, the type of research constitutes another avenue for evaluation. Throughout the papers reviewed in this study, and as shown in Figure. AI.3, most of the papers employed qualitative methods to understand IPD. Indeed, almost 57% of the studies were qualitative. Conversely, studies using quantitative data amounted to 27%, while only 12% of the studies used the mixed method where both qualitative and quantitative data were collected. In addition, a small fraction that did not exceed 4% was for studies that used some sort of conceptual data.

Application domains

Many studies attempted to investigate IPD using a case study approach. That being said, this approach was not utilized homogenously across the sample. Indeed, case studies were rarely used in many countries where IPD is still in the early stages of adoption. Thus, finding cases to study that utilized IPD as a project delivery system was a barrier to this research approach. Therefore, only 46% of the selected research were case studies investigating an IPD or collecting data from persons directly involved in the IPD project. Those papers were classified into six categories based on the application domain, as shown in Figure. A I.4. Institutional (i.e., federal building, hospital, university), which is the most represented domain with 37% of the cases, Infrastructure (i.e., bridges, highways, dams), which the second most represented domain with 20 % of the cases. Next, the Residential and commercial (i.e., office buildings, housing, commercial centers) and the Industrial (i.e., factories, oil, and gas plants) appeared in 12% and 4% of the cases, respectively.

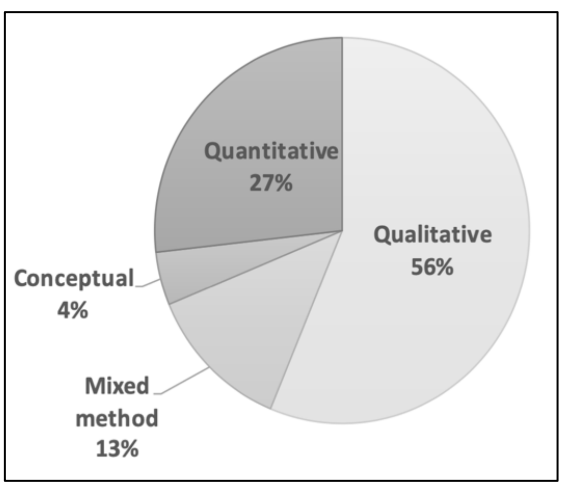

Figure A I.3 Research publication per data type

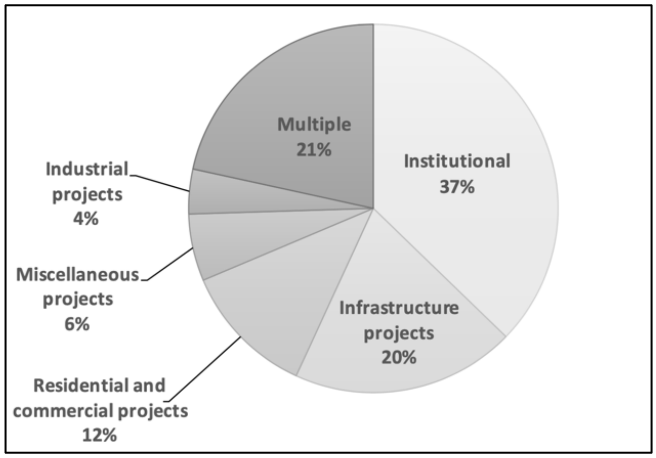

Figure A I.4 Research publication per application domain

Lastly, two more categorizations are provided to serve the studies that do not fall under the categories mentioned above. Miscellaneous research studied project types not included in the previous categories, e.g., renovation projects, and Multiple for research that studied projects from more than one domain.

Subject area

Finally, and potentially most importantly, the research trends on IPD were investigated to identify the topics and the addressed subjects, which can help frame the needs and gaps, which would shape future trends in IPD research. The selected studies were categorized into five different groups. Nonetheless, it is worth mentioning that the same study could be classified under more than one category in many cases. There is no clear dividing line between those categories, resulting in some research under two or even three categories. However, in this study, to simplify and clarify the research trends around IPD, the researcher

meant to classify each study under one category based on the most addressed topic in the study. As illustrated in Table A I., most of the research reviewed in this study can be classified under two subject areas, principles of IPD with 37 articles (33%) and implementation of IPD with 33 articles (30%). The next subject area that made up a considerable share of the research topics is the integration between IPD and building information modeling (BIM), which were addressed in 21 different studies representing 19% of the total reviewed studies. The next in line are the barriers and challenges; this topic was addressed in 12 research representing 11% of the total studies. Moreover, lastly, the subject that brought the least attention is solving the barriers of IPD adoption, which were addressed in 9 studies that speak for only 8% of the total reviewed studies.

Table A I.1 Classification based on the subject area

Subject area	**Description**	**Number of articles**
Principles	Papers around the principles of IPD, an introduction to IPD, the need for IPD.	37
Implementation	Papers investigated the circumstances of IPD implementation through a case study or the implementation attempts within a specific region or country.	33
Barriers and challenges	Papers around the barriers and challenges of IPD adoption and implementation.	12
Solving barriers	Papers that are dedicated to understand and propose solutions to the barriers of IPD adoption.	9
IPD and BIM	Papers that looked into integrating the IPD and BIM or addresses IPD and BIM together as innovative tools and approaches to the construction industry.	21

Conclusions

This study aims to discover the research trends of IPD over the last four years from 2017 to 2020, driven by the increase in the popularity of this innovated and promising approach and the rise in the number of studies that addressed IPD in recent years, which make it paramount to understand what has been accomplished and identify the current trends on IPD research. Therefore, determine the needs and gaps that should be addressed in future research while the IPD is gaining more popularity and is expected to spread in more regions around the world due to the general dissatisfaction with the construction industry's performance.

The last four years from 2017 to 2020 represent a continuation of the growing trend in IPD research, where 112 papers were published in the form of a journal or conference articles. This trend still can grow, as more and more projects are starting to adopt IPD and more successful stories of projects that employed IPD is spreading. This deployment would drive both researchers to reveal any vague understanding of IPD and industry parties who will be more willing to take steps towered adapting IPD.

Although 28 different countries have contributed to the efforts of IPD research in the last four years, more local research and case studies are needed to promote the adoption of IPD in more construction markets. The concepts of IPD still unknown in many construction markets around the world. There is a need for pioneers who could act as early adopters of IPD hand by hand with conducting local research on IPD to promote this innovative and collaborative delivery system.

The principles and the implementation of IPD were the most two addressed topics in the last four years, 2017 to 2020; however, as more new construction markets in different countries would enter and practice the IPD system, the need for studies that address the challenges and the barriers and ways to solve that barrier in the new markets are paramount. In addition, most case studies in the published research are around institutional and infrastructure projects, which usually involve a high level of complexity. However, the problems of the construction industry are not limited to those project types only. Therefore, there is a need for more (low-medium) complexity-level case studies to test the effectiveness of IPD in managing different projects sizes.

Eventually, it should be noted that this paper proposes an initial review that will be further developed in a follow-up full-length journal paper where the results of this investigation will be presented in more depth.

Acknowledgments

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ANNEX II

CONFERENCE PAPER: INTEGRATED PROJECT DELIVERY (IPD) IN QUEBEC: EXPLORING AWARENESS, PERCEPTIONS, AND CHALLENGES

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Abstract

With increasing empirical evidence showcasing IPD's capability to improve project outcomes and elevate construction processes, its adoption is rising across Canada. Yet, despite this growing trend, Quebec remains an exception, with no documented IPD projects to date. However, recent conversations and discussions within academic and industrial circles indicate that Quebec is poised to explore the benefits of IPD, potentially gearing up for its debut IPD project in the foreseeable future. Within this context, this paper aims to explore the awareness, perceptions, and challenges associated with adopting IPD in Quebec, aiming to provide an in-depth understanding of where Quebec stands in relation to IPD and offer a valuable guide for policymakers, industry stakeholders, and academic researchers aiming to advance this collaborative project delivery approach. Accordingly, a quantitative survey methodology was utilized. A comprehensive statistical approach incorporating both descriptive and inferential statistics was employed to analyze the data. The results showcase the state of IPD knowledge and awareness among construction professionals in Quebec, namely highlighting a gap between awareness and practical application. Despite this, a positive perception of IPD's potential to enhance project outcomes is evident, with a highly positive perception of the foundational elements of IPD in Canada. In addition, the analysis showed a general consensus on the level of comfort in implementing IPD principles. The survey also identifies significant challenges to IPD implementation, including legal and contractual difficulties and the prevailing industry culture. The study concludes that, despite the favorable perceptions of IPD's ability to enhance construction industry outcomes, Quebec's construction industry would benefit from a holistic approach that promotes well-informed awareness and training in IPD and addresses the foundational challenges raised to ensure a seamless adoption of this innovative project delivery approach.

Keywords: Integrated Project Delivery (IPD), Quebec, IPD Awareness, IPD Perceptions, IPD Challenges.

Introduction

The construction Iindustry in Quebec is a cornerstone of the provincial economy, representing a significant sector that contributes 6.4% to Quebec's employment and 7.0% to its GDP. The sector's activities also stimulate activities across manufacturing, trade, and service sectors, representing significant indirect economic benefits and highlighting its integral role in Quebec's broader economic fabric (NAICS, 2023). However, this industry faces numerous challenges, including labor shortages, project delays, cost overruns, and the need for sustainable building practices (BAnQ Numérique, 2017). These issues reflect broader struggles within the construction sector, such as project complexity, variability in client needs, high risks, technology adoption, and complex coordination and decision-making processes among multiple stakeholders (Bourgault et al., 2021).

In response to these challenges, Quebec is exploring innovative solutions to improve the efficiency, sustainability, and overall success of construction projects. One such solution involves the Société québécoise des infrastructures (SQI) pioneering the adoption of Integrated Project Delivery (IPD) in Quebec, setting the stage for the province's first IPD project (SEAO, 2023). IPD is a collaborative approach to construction that brings together all stakeholders (owners, architects, builders, and engineers) from the project's early stages to completion. IPD emphasizes mutual respect, shared risk and reward, and open communication, aiming to streamline the construction process, reduce waste, and ensure that projects are completed on time and within budget (AIA, 2007).

This initiative reflects a willingness to embrace collaborative models that have shown success in other Canadian provinces and around the globe. In 2023, the Integrated Project Delivery Alliance (IPDA) documented 106 IPD projects, the majority of them in British Columbia, Alberta, and Ontario (IPDA, 2023). The Canadian documented cases of IPD have shown to be successful in completing projects on time and within budgets, creating a conducive collaborative environment, achieving higher project satisfaction levels, and better overall project outcomes (Poirier et al., 2022). By adopting IPD, Quebec aims to realize similar benefits, including improved project efficiency, sustainable building practices, and greater innovation in construction projects. However, the success of this transition is contingent upon a deep understanding of the current state of awareness, perceptions, and challenges perceived by the industry's professionals regarding IPD. It raises critical questions about readiness, potential barriers to adoption, and the necessary conditions for fostering a collaborative project delivery culture. These considerations underscore the importance of this study, which seeks to illuminate the perspectives of Quebec's construction professionals on IPD, offering insights into the steps required to leverage IPD's full potential.

Background

IPD represents a collaborative approach to project delivery that aims to transform the construction industry away from its traditionally fragmented operations. This transformation seeks to address the persistent inefficiencies in delivering projects on time and within budget while meeting stakeholders' expectations (Kent & Becerik-Gerber, 2010) This approach enables intensive planning, laying the groundwork for a collaborative and supportive project culture, setting clear goals, and ensuring a collective commitment (Allison et al., 2018). IPD champions the values of trust, transparency, and open accounting, which are crucial in fostering a culture of unity among team members and overcoming the barriers that have historically hindered project efficiency and effectiveness (Pishdad-Bozorgi & Beliveau, 2016).

IPD Characteristics

The literature on IPD highlights several key characteristics that contribute to its success. An extensive literature review identified the main characteristics of IPD for use in the survey. Twenty elements representing the core of the IPD approach were collected, as seen in Appendix B (Q13 and Q14). These characteristics include but are not limited to subcontractors' early involvement, financial transparency, joint decision-making, shared risk and rewards, and the integration of Lean tools (AIA, 2007; Cheng, 2012; Viana et al., 2020). Each characteristic contributes uniquely to the IPD model, fostering an environment where collaboration thrives, risks are collectively managed, and project objectives are shared and committed among team members (Yee, 2017; Ashcraft, 2011; Mei et al., 2022). In the methodology and the results sections, the use of the identified list of IPD characteristics in the context of this study to gauge the perception of Quebec construction professionals on their impact on project success and the readiness to implement them is detailed.

Challenges to IPD Implementation

Despite its potential, the adoption of IPD faces significant challenges, and these challenges have been well explored within different regions and markets. These challenges range from contractual and legal difficulties, which require navigating complex agreements and liability concerns within different regions and jurisdictions, to cultural and organizational obstacles, such as resistance to change and the difficulty of fostering trust and transparency among traditionally competitive parties (Ghassemi & Becerik-Gerber, 2011; Ebrahimi & Dowlatabadi, 2019; Sherif et al., 2022; Khanna et al., 2021; Arar & Poirier, 2022; Sari et al., 2023; Forero et al., 2015).

This study identified a list of 15 most relevant challenges to IPD adoption and implementation through an extensive literature review, as seen in Appendix B (Q16). These challenges include but are not limited to legal and contractual barriers, prevailing industry norms, and general resistance to profit-sharing, which hinder the broader acceptance of IPD. In the methodology and the results sections, the use of the identified list of IPD challenges in this study's context to gauge Quebec construction professionals' perception of their impact on IPD implementation is detailed.

Understanding the perceptions of Quebec's construction professionals regarding IPD's characteristics, its impact on project performance, and the challenge of implementation is pivotal. This assessment is timely and essential, as it sheds light on the current state of awareness, knowledge, and acceptance of IPD within the industry. Such insights are invaluable for strategizing a more effective adoption pathway, ensuring that IPD's potential benefits are fully realized and, therefore, leading to broader acceptance across the sector.

Methodology

The study employed a survey research design to explore IPD awareness, perceptions, and challenges within the Quebec construction industry. Constructed using the LimeSurvey platform, the questionnaire was disseminated online in both French and English. The survey utilized a convenience sampling approach, which is a sampling strategy in which participants are chosen according to their accessibility; its simplicity and efficiency make it a suitable choice for this study, despite its lack of obvious generalizability when compared to probability sampling (Jager et al., 2017). The survey targeted individuals involved in the Quebec construction industry, such as owners, general contractors, engineering professionals, architects, Specialized contractors, and suppliers. Data collection was carried out in the latter half of 2023, with potential respondents receiving email invitations to participate in the online survey.

Survey Design

The survey comprised three different parts preceded by a consent section. The initial segment focused on demographic data, collecting information about the participants' roles, organizational domain, sectors, scale, size, and the geographical reach of their operations. This foundational data aimed to contextualize the subsequent findings within the Quebec construction industry.

Following the demographic section, the survey's second part sought to gauge the level of IPD awareness and current state of knowledge and familiarity among construction industry professionals. Using a five-point Likert scale to measure responses, the third part assessed participants' perceptions regarding the impact of IPD characteristics on project success. It also explored the industry readiness and confidence in implementing IPD characteristics in Quebec. In addition, the survey assessed the perceived impact of IPD on the project performance indicators. Lastly, the perceived barriers to IPD implementation and critical challenges and considerations necessary for successful IPD integration within the Quebec construction sector were explored.

Survey Settings

From the 203 responses collected, 86 were deemed valid and complete for analysis. Given that the total workforce in Quebec's construction industry is approximately 269,800 workers, as reported by (NAICS, 2023), the survey's parameters were established. A 95% confidence level was chosen, signifying that the calculated confidence intervals are 95% likely to encompass the true population parameter. The margin of error was calculated employing a formula that includes the finite population correction (FPC) (Groves et al., 2009):

$$E = Z \times \sqrt{(\sigma^2 \div n) \times ((N - n) \div (N - 1))} \qquad \text{(A II.1)}$$

Where E is the margin of error, n is the sample size equal to 86, σ is the standard deviation assumed to be 0.5, and Z equals 1.96 is the Z-score for a 95% confidence level.

Upon running the calculation, the margin of error was determined to be ±10.56%. This indicates that, at a 95% confidence level, the survey results are expected to accurately estimate the true parameter within the Quebec construction industry workforce, with a margin of error of ±10.56%.

Survey Analysis

The study used both descriptive and inferential statistical methods. Initially, descriptive statistics such as mean, mode, median, and standard deviation were calculated for each survey question. These measures provided an initial understanding of the data distribution and central tendencies, setting the stage for a more nuanced analysis (Mishra et al., 2019).

To delve deeper into the data, mainly focusing on the third section of the survey, which included four distinct 5-point Likert scale questions, inferential statistics were employed. The objective was to establish the statistical significance of the observed differences in responses. For this purpose, the R programming language was utilized to perform the Friedman test, a non-parametric statistical analysis method chosen for its suitability to the data's characteristics.

The selection of the Friedman test was made due to its appropriateness for handling ordinal data, such as that derived from Likert scales, and its compatibility with non-parametric datasets, which are not required to adhere to a normal distribution (Cleophas & Zwinderman, 2016). This method was deemed ideal for the analysis because it accommodates scenarios where responses are gathered from a single group across multiple conditions or occasions, aligning closely with the structure of our data where a singular respondent group evaluated multiple characteristics of IPD/ Performance indicators/Challenges in this survey.

Results

Through a comprehensive questionnaire, insights were gathered from a broad spectrum of professionals to gauge their familiarity with IPD, assess their level of knowledge, understand their perception of the impact IPD could have on projects' success, and the perceived challenges that could influence the successful implementation of IPD in Quebec.

Demographic Characteristics of Participants

Out of a total of 203 responses received, 86 were considered complete and valid for analysis, with the remainder being incomplete, junk, or duplicates. This set of responses represents a broad range of Quebec construction industry practitioners, evident by the detailed overview of the demographics of the survey participants, providing a solid foundation for analyzing the perceptions and impact of IPD within this context.

Organization types among respondents varied, with a significant presence of architecture firms accounting for (23.3%) of the sample, closely followed by specialty contractors (17.4%), then clients, and general contractors, each constituting (16.3%). Sector-wise, a broad coverage across different construction domains was apparent. The respondents were able to choose more than one sector if applicable, and the results show that a substantial number of respondents are engaged in the commercial (60.5%) and institutional (74.4%) sectors, while the residential and industrial sectors were also well represented, with (41.9%) and (47.7%) respectively. Civil infrastructure and roadworks, however, were less prevalent, involving only (18.6%) of the participants.

Geographically, the survey drew insights from a varied operational reach of the surveyed entities, where (32.9%) of the companies operate regionally within specific areas of Quebec, (41.2%) have province-wide operations across Quebec, and (25.9%) extend their operations nationally or provincially outside Quebec.

Regarding organizational scale, the survey found a balanced representation across various economic sizes with little tendency towards large-scale organizations, as shown in Figure A II.1, 'Estimated Company Turnover,' and Figure A II.2, 'Employee Count.'

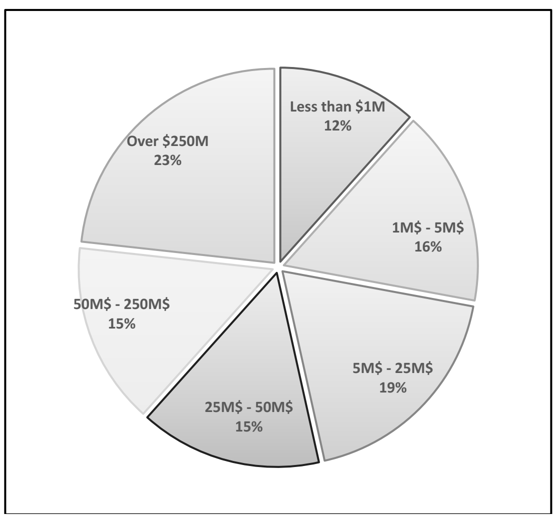

Figure A II.1 Estimated Company Turnover

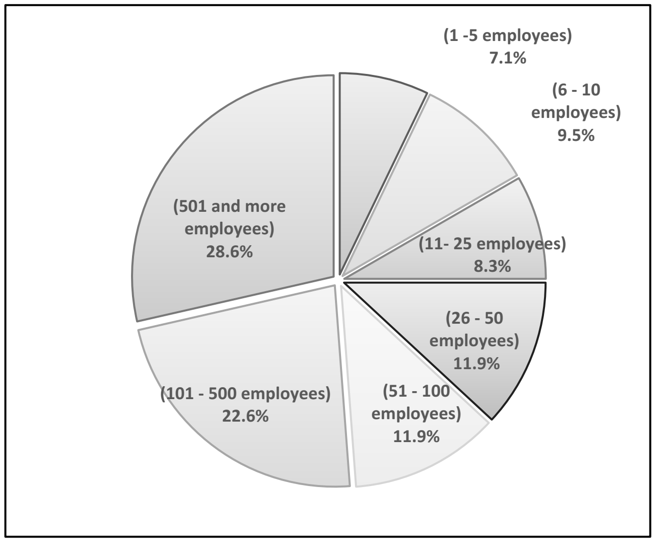

Figure A II.2 Employee Count

In the last demographic aspect, the positions held by respondents underscore the sample representation at different organizational levels, with a significant 46.5% occupying executive leadership or company management roles. Project managers comprised 24.4% of the sample. Other specified roles, such as innovation managers, estimators, construction managers, and design professionals, accounted for smaller percentages, but collectively, they enriched the dataset with a broad range of industry perspectives.

Awareness of IPD in the Quebec Construction Industry

After the demographic section, the survey was set to assess the awareness of IPD within the Quebec construction industry and explore the current state of knowledge and experience with IPD among professionals. Initially, respondents were asked about their familiarity with IPD, revealing that 61.6% of participants were aware of the concept, whereas 38.4% reported no familiarity. This initial data point indicates a considerable level of awareness within the industry, although there is still a portion of the sample not familiar with the IPD concept.

Further exploring the depth of understanding among those familiar with IPD, the survey asked respondents to self-assess their level of knowledge. The results indicate a largely basic understanding of IPD, with 48.1% of respondents classifying their knowledge as basic, followed by 28.8% at an intermediate level, 19.2% advanced, and a minimal 1.9% considering themselves as experts, as shown in Figure A II.3. This distribution suggests that while there is a fair awareness of IPD, the majority of respondents familiar with IPD possess only a foundational understanding, highlighting a potential gap in comprehensive knowledge and expertise in the field.

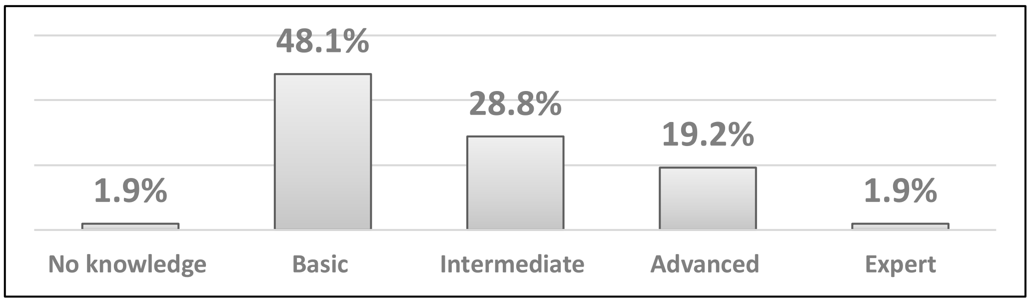

Figure A II.3 Level of knowledge regarding IPD

Participation in IPD projects, whether real or educational, was also queried, with only 23.1% of those familiar with IPD having participated in such projects. This low participation rate (76.9% have not participated) further illustrates the initial stage of IPD adoption and the experience gap within the Quebec construction industry.

For those initially unfamiliar with IPD, upon presenting a detailed definition, nearly half (46.9%) recognized the contractual method that IPD represents. This suggests an underlying awareness that might not have been initially expressed by the term Integrated Project Delivery (IPD, Réalisation de projet intégrée (RPI) in French) alone. These findings revealed a moderate level of awareness and basic understanding of IPD among Quebec construction professionals, with a notably low rate of direct participation in IPD projects.

Perceptions of IPD Characteristics' Impact on Project Success in Quebec

A 5-point Likert scale, ranging from very negative to very positive, was utilized to gauge perceptions regarding 20 characteristics of IPD and their influence on project success. The analysis of survey responses highlights areas of broad agreement on their benefits to project success, as well as aspects that provoke more divided opinions. The detailed statistical breakdown, including mean, mode, median, and standard deviation for each characteristic, offers a nuanced understanding of the industry's current perception of IPD, as shown in **Table A II.**1.

The mean ratings indicate a generally positive perception of IPD attributes, with "Selection of team members based on best value" and "Integration of team members into multidisciplinary work teams" receiving the highest average scores of approximately 4.48 and 4.47, respectively. This suggests a strong consensus on the value of collaborative team composition and interdisciplinary integration in enhancing project outcomes.

Conversely, "The waiver of lawsuits between the signatories to the contract" and "Risk sharing among project participants" were among the characteristics with lower mean scores of 3.59 and 3.82, indicating areas within IPD that may require further attention or present challenges in perception among industry professionals.

Table A II.1 IPD Characteristics Impact on Project Success

Rank	IPD Characteristic	Mean	Mode	Median	Standard Deviation	Rank	IPD Characteristic	Mean	Mode	Median	Standard Deviation
1	Selection of team members based on best value	4.48	5	5	0.62	11	Implementation of a "Big Room"	4.18	4	4	0.68
2	Integration into multidisciplinary work teams	4.47	5	5	0.6	12	Absolute financial transparency	4.17	5	4	1.08
3	Alignment around project values and objectives	4.47	5	4.5	0.57	13	Implementation of new technologies including BIM	4.1	4	4	0.75
4	Mutual trust between project team members	4.43	5	5	0.67	14	Joint and collaborative decision-making	4.08	4	4	0.96
5	Display and visual planning	4.33	4	4	0.66	15	Continuing training within the project	4.08	4	4	0.77
6	Mode of delivery focusing on relationships	4.32	4	4	0.75	16	Continuous performance measurement	4.07	4	4	0.76
7	Upstream involvement of subcontractors and suppliers	4.2	4	4	0.93	17	The use of Lean tools	4	4	4	0.74
8	Incentives linked to overall performance	4.2	4	4	0.78	18	Risk sharing among project participants	3.82	4	4	1.13
9	Project at a target cost determined by everyone	4.2	4	4	0.82	19	Signing of a multi-party contract	3.83	4	4	1.15
10	Sharing of rewards among project participants	4.2	4	4	0.73	20	Waiver of lawsuits between the contract signatories	3.59	4	4	1.32

The modes for most characteristics align with the highest frequency ratings of 4 and 5, reinforcing the overall positive stance towards IPD principles, though with notable variance indicated by the standard deviation values. For instance, the relatively high standard deviation in ratings for "The signing of a multi-party contract" (SD=1.15) and "The waiver of lawsuits between the signatories to the contract" (SD=1.32) underscores the diversity in opinions on these aspects, suggesting that while many see significant benefits, a considerable number of respondents hold reservations.

In the last step, the descriptive analysis of the perceptions of IPD characteristics and their impact on project success was supplemented with the use of inferential statistics (Friedman test) to assess whether the observed differences in ranking IPD characteristics are statistically significant. The analysis revealed significant differences in the ranking of the 20 IPD characteristics (Friedman chi-squared = 86.44, df = 19, p-value = 1.408e-10 $<$ 0.05), suggesting that certain IPD principles are perceived to have a more substantial impact on project success than others.

Readiness for Implementing IPD Quebec

Utilizing a 5-point Likert scale, from very uncomfortable to very comfortable, the survey aimed to understand the ease with which professionals could adopt 20 distinct IPD characteristics in their projects. The collected responses provided a detailed statistical analysis, which is sorted discerningly in **Table A II.2**.

The analysis reveals a generally positive comfort level with IPD implementation, with "The integration of team members within multidisciplinary work teams" leading with a mean score of 4.38, closely followed by "Alignment of project participants around the values and objectives of the project" with a mean of 4.28. These top-rated characteristics underscore a strong consensus among respondents on the importance of team integration and alignment with project values for successful IPD implementation.

Table A II.2 Industry Readiness and Confidence in Implementing IPD Characteristics in Quebec

Rank	IPD Characteristic	Mean	Mode	Median	Standard Deviation	Rank	IPD Characteristic	Mean	Mode	Median	Standard Deviation
1	The integration of team members within multidisciplinary work teams	4.38	4	4	0.67	11	Identifying and carrying out the project at a target cost	3.98	4	4	0.85
2	Alignment of project participants around the values and objectives of the project	4.28	4	4	0.74	12	Continuous performance measurement	3.88	4	4	0.96
3	Selection of team members based on best value	4.2	4	4	0.85	13	Incentives linked to the overall performance of the project	3.83	4	4	0.94
4	Upstream involvement of subcontractors and suppliers	4.14	5	4	1.03	14	A mode of delivery that focuses on the relationships between the project participants	3.78	4	4	0.87
5	Continuing training within the project	4.14	4	4	0.78	15	Sharing rewards between project participants	3.74	4	4	1.04
6	Mutual trust between project team members	4.12	4	4	0.86	16	The use of Lean tools	3.72	4	4	0.93
7	Display and visual planning, through the Last Planner system	4.12	4	4	0.9	17	The signing of a multi-party contract	3.49	4	4	1.19
8	Joint and collaborative decision-making	4.1	4	4	0.85	18	Absolute financial transparency between team members	3.48	4	4	1.22
9	Implementation of new technologies including BIM	4.1	4	4	0.91	19	Risk sharing among project participants	3.48	4	4	1.17
10	The implementation of a “Big Room” or a collaborative meeting space	4.09	4	4	0.76	20	The waiver of lawsuits between the signatories to the contract	3.26	4	3	1.29

On the other hand, characteristics such as "The waiver of lawsuits between the signatories to the contract" and "Risk sharing among project participants" received the lowest comfort levels, with mean scores of 3.26 and 3.48, respectively. This indicates particular areas within IPD that might pose implementation challenges or cause hesitation among industry professionals, pointing to potential barriers to the full adoption of IPD principles.

Modes for most characteristics equals 4, reflecting a general agreement on the comfort of implementing these IPD principles despite the observed variability in comfort levels, as indicated by standard deviation values. For instance, "The waiver of lawsuits between the signatories to the contract" and "Absolute financial transparency between team members" exhibited higher standard deviations (1.29 and 1.22, respectively), highlighting varied comfort levels among respondents and suggesting divergent views on these aspects of IPD.

Lastly, the results of Friedman test revealed significant differences in ranking the readiness and confidence in implementing IPD characteristics (Friedman chi-squared = 117.39, df = 19, p-value = 3.4e-16 < 0.05), suggesting that industry practitioners perceived the readiness and confidence in implementing certain IPD principles to be more comfortable and manageable than others.

Anticipated Impact of IPD on Project Performance Indicators in Quebec

The next question delves into the industry professionals' perspectives in Quebec regarding the anticipated impact of IPD on key project performance indicators. Utilizing a 5-point Likert scale, from very negative to very positive, the survey sought to capture insights on 29 distinct performance indicators and their perceived influence on project success. A statistical breakdown of the responses is provided in **Table A II.3**.

The aggregated data from the responses reveal an overall optimistic outlook toward IPD's potential to enhance project outcomes. Notably, "Early detection of conflicts and issues" and "Project constructability" emerged as the top-rated performance indicators, with mean scores of 4.57 and 4.4, respectively. These findings reflect a strong industry consensus on the importance of IPD early collaboration and multidisciplinary team integration in enhancing the project's construction ability and detecting conflicts early.

Conversely, indicators such as "Construction waste reduction" and "Project risk management" received the lowest mean scores of 3.64 and 3.72. Although it still indicates a positive perception, these scores point to areas where IPD is perceived to be less effective among professionals.

The consistency of mode values at 4 and 5 across the majority of indicators reinforces the overall positive outlook toward IPD. However, variations in opinions, as signified by the spread of standard deviation values, particularly for "Decision-making time" (SD=1.15) and "Team productivity" (SD=0.97), reveal a broad range of perspectives regarding IPD effectiveness.

Table A II.3 Perceived Impact of IPD on Project Performance Indicators

Rank	Performance Indicator	Mean	Mode	Median	Standard Deviation	Rank	Performance Indicator	Mean	Mode	Median	Standard Deviation
1	Early detection of conflicts and issues	4.57	5	5	0.5	16	Fiscal transparency in projects	3.98	4	4	0.89
2	Project constructability	4.4	4	4	0.57	17	Schedule performance reliability	3.98	4	4	0.77
3	Team cohesion	4.29	4	4	0.67	18	Risk ownership	3.92	4	4	0.87
4	Team integration and Collaborative Practices	4.25	4	4	0.73	19	Value for money	3.92	4	4	0.85
5	Overall project performance	4.23	4	4	0.7	20	Team productivity	3.9	4	4	0.97
6	Team engagement and ownership	4.19	4	4	0.77	21	Inquiries processing time	3.83	4	4	0.89
7	Project change management	4.19	4	4	0.74	22	Change order processing Time	3.81	4	4	0.9
8	Cost performance reliability	4.15	4	4	0.72	23	Ongoing project costs	3.81	4	4	0.76
9	Frequency of issues and defects	4.13	4	4	0.66	24	Overall project cost	3.79	4	4	0.77
10	Owner-Contractor relationship	4.11	4	4	0.7	25	Total duration of the project	3.79	4	4	0.89
11	Design-related changes	4.11	4	4	0.85	26	Decision-making time	3.77	4	4	1.15
12	Number of request for information (RFI)	4.08	4	4	0.7	27	Work environment quality	3.74	4	4	0.84
13	Owner satisfaction	4.04	4	4	0.73	28	Project risk management	3.72	4	4	0.93
14	Team member satisfaction	4.04	4	4	0.83	29	Construction waste reduction	3.64	3	3	0.74
15	Quality of project deliverables	3.98	4	4	0.8						

The results of the Friedman test confirmed this optimism in the anticipated impact of IPD on certain performance indicators, revealing significant differences in ranking the performance indicators (Friedman chi-squared = 176.36, df = 28, p-value < 2.2e-16 < 0.05), suggesting that industry practitioners perceive the impact of IPD on certain performance indicators to be greater than on others.

Perceived challenges in the implementation of IPD

In the last part of the survey, the impact of various challenges on the implementation of IPD was assessed. Utilizing a 5-point Likert scale that ranged from no impact to very high impact, industry professionals' perceptions regarding 15 significant challenges to IPD implementation were gathered and analyzed. This question aims to shed light on the consensus and divergences within the industry regarding these implementation hurdles, as evidenced by a detailed statistical overview shown in **Table A II.4**.

Table A II.4 Perceived Challenges to Implementing IPD in the Construction Industry

Rank	Challenge	Mean	Mode	Median	Standard Deviation	Rank	Challenge	Mean	Mode	Median	Standard Deviation
1	Legal and contractual difficulties	4.31	5	4	0.87	9	High initial costs of IPD adoption	3.86	4	4	0.76
2	Prevailing industry culture and practices	4.22	5	5	1.03	10	Limited client demand for IPD	3.84	4	4	1.01
3	Lowest bidder procurement practices	4.16	5	4	0.94	11	Confidence deficit in IPD effectiveness	3.7	3	4	0.94
4	Profit-sharing resistance	4.06	5	4	1.03	12	Inadequate motivation and incentives for IPD participation	3.67	4	4	0.97
5	Knowledge gap in IPD principles	4.04	5	4	1	13	Lack of familiarity with Lean principles and tools	3.67	4	4	0.95
6	Inequities in risk and reward sharing	4	5	4	1.02	14	Complexity of IPD implementation	3.65	4	4	0.86
7	Client unawareness of IPD advantages	4	4	4	0.94	15	Insufficient industry support for IPD	3.53	3	4	0.89
8	ROI ambiguity in IPD projects	3.86	4	4	0.87						

The survey's findings reveal that "Legal and contractual difficulties" and "Prevailing industry culture and practices" received the highest mean scores of 4.31 and 4.22, respectively, indicating a perceived significant impact of legal frameworks and industry norms on hindering IPD implementation, highlighting the critical need for legal and cultural shifts to foster IPD's broader acceptance.

On the other hand, challenges such as "Insufficient industry support for IPD" and "Complexity of IPD implementation" were ranked lower, with mean scores of 3.53 and 3.65, respectively. Although still considered impactful, these areas might represent more manageable challenges or ones that respondents feel can be overcome with targeted strategies and increased awareness.

The prevalence of the highest frequency ratings, at 4 and 5, indicates an overall acknowledgment of the substantial impact these challenges pose to IPD implementation. Nevertheless, the variation in responses, as indicated by the standard deviation measures, points to differing opinions on the severity of these impacts. For instance, "Profit-sharing resistance" and "Prevailing industry culture and practices," with standard deviations of 1.03 for both, reflect a broad spectrum of views, suggesting an industry divided on the influence of these issues.

The results of the Friedman test revealed a significant difference in ranking the challenges (Friedman chi-squared = 68.514, df = 14, p-value = 3.582e-09 < 0.05), indicating that industry practitioners perceive the impact of certain challenges to IPD implementation to be greater than on others.

Building upon the results of the quantitative question mentioned above, insights from a free text question further enrich the understanding of the challenges to IPD implementation. Respondents were asked to mention the three most significant challenges they perceived, and the responses were thematically categorized, as shown in **Table A II.**5. "Contractual and Legal Challenges" emerged as the top cited challenge, with "Collaboration" and "Resistance to Change" following closely. This qualitative feedback confirms the quantitative findings, emphasizing legal and contractual barriers as the main hindrances. Moreover, the call for improved collaboration and the need to overcome resistance to change highlight critical areas for developing a conducive environment for IPD. Other notable challenges identified include "Knowledge and Understanding of IPD that points towards the necessity for enhanced IPD-related education and training strategies to support IPD's successful implementation.

In synthesizing the results from both the quantitative and qualitative questions, it becomes clear that addressing legal, cultural, and educational barriers, alongside fostering an environment conducive to collaboration and transparency, is crucial for unlocking IPD's potential to transform the construction industry.

Table A II.5 Frequency Distribution of Challenges in Implementing IPD from Open-Ended Survey Responses

Challenge Theme	Frequency
Contractual and Legal Challenges	33
Collaboration	25
Resistance to Change	15
Knowledge and Understanding of IPD	13
Project Management and Execution	12
Stakeholder Alignment and Engagement	12
Trust	10
Financial and Budget Concerns	9
Transparency and Open Communication	7
Technological Adoption	2

Discussion

This study delved into the current state of awareness, perceptions, and readiness for IPD, alongside identifying significant challenges that could hinder its broader acceptance within the Quebec construction industry. The results of this study align with the literature review highlighted in the background section, shedding light on the Quebec construction industry's perceptions of IPD's potential impact and its perceived challenges.

The study findings revealed a fair awareness of IPD among Quebec construction professionals. However, this awareness predominantly reflects a foundational understanding, indicating a potential gap in comprehensive knowledge and expertise in the field. This was evidenced by the small proportion of those familiar with IPD who had actually engaged in such projects. This low participation rate underscores the initial stage of IPD adoption and the presence of an experience gap within the industry. These observations suggest that while IPD is recognized, a notable deficiency exists in both in-depth understanding and practical application among professionals in the Quebec industry.

Moreover, the survey's findings on the perceptions of IPD characteristics revealed a strong consensus on the value of collaborative team composition and integrating multidisciplinary teams in improving project outcomes and achieving success. This mirrors findings from other jurisdictions, emphasizing a broader agreement on the benefits of such approaches (Forero et al., 2015). Yet, the hesitancy towards certain IPD principles, highlighted by the high standard deviations in responses to the signing of the multi-party contract and the waiver of lawsuits, indicates a division of opinions from significant benefits to considerable reservations regarding these aspects. This hesitance contrasts with the perceptions in other jurisdictions where the contractual aspect of IPD was positively perceived (Mei et al., 2022).

In addition, inquiring about the readiness and confidence in implementing IPD characteristics in Quebec among industry professionals revealed a generally positive comfort level with IPD implementation, with a strong consensus on the essential role of team integration and alignment with project values for successful IPD implementation. This resonates with the success stories documented in other regions (Poirier et al., 2022). Yet, specific IPD aspects, such as the waiver of lawsuits and absolute financial transparency, showed higher standard deviations, reflecting varied levels of comfort and divergent views among the respondents. These findings suggest that while there is a general positive comfort level with IPD implementation, hesitations and challenges regarding some IPD aspects exist and could hinder the full adoption of IPD practices.

Regarding IPD challenges, the perceived impact of legal and contractual difficulties and prevailing industry culture and practices as significant barriers to IPD implementation was notably highlighted, emphasizing the essential need for careful consideration of both legal and cultural domains to foster wider acceptance of IPD. This consensus reflects the observations of similar research conducted across Canada, indicating a broader recognition of the important role that legal, cultural, and educational barriers play in the adoption and successful implementation of IPD (Bhonde et al., 2020).

Conclusions

The study findings have revealed a general consensus on the value of IPD in enhancing project efficiency and improving outcomes in the Quebec construction industry. It also demonstrated a fair level of knowledge regarding IPD. However, the findings point to significant gaps in both the depth of understanding of IPD and its practical application. This gap, coupled with uncertainties around certain IPD principles, such as the lawsuit waiver and signing of a multiparty contract that poses ambiguity to the industry practitioners, sheds light on the importance of addressing legal, cultural, and educational challenges that could currently be restricting a broader acceptance in Quebec.

The findings underline that Quebec is in the early stages of IPD adoption. Therefore, considerable effort is needed to promote awareness, expand knowledge, and increase practical engagement with IPD. Accordingly, a holistic approach that promotes well-informed awareness and training in IPD and addresses the foundational challenges is necessary to foster IPD adoption successfully. Such efforts should highlight IPD's benefits and equip stakeholders with the tools and knowledge to navigate its principles effectively.

The study encountered a few limitations. First, the study relied on a convenience sampling approach, which may limit the ability to generalize the results. Second, the study used self-assessment questions regarding knowledge, understanding, and perception of IPD. Therefore, a self-assessment bias, where respondents may overestimate or underestimate their level of knowledge, could be expected. For future research, it is recommended to investigate aspects that pose hesitation among Quebec industry professionals, such as the lawsuit waiver and the multi-party aspects. Investigating these aspects in further detail could help the industry overcome these challenges and understand their role and impact within the IPD approach.

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ANNEX III

CONFERENCE PAPER: EXPLORING INTEGRATED PROJECT DELIVERY THROUGH THE LENS OF INNOVATION DIFFUSION THEORY: ITS ROLE IN EVOLVING ORGANIZATIONAL PRACTICES

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Abstract

Integrated Project Delivery (IPD) is recognized as an innovative project delivery method that breaks away from traditional construction management practices and transforms project dynamics through integration and collaboration. Despite its potential, the diffusion of IPD within organizations remains underexplored. Drawing upon Innovation Diffusion Theory, this study investigates how IPD, as an innovation, diffuses within organizations, influencing organizational practices within the architecture, engineering, and construction (AEC) sector. Through a mixed-methods approach, a survey of professionals with IPD experience from both public and private sectors was conducted, followed by in-depth interviews with seven senior management representatives of organizations heavily involved in IPD projects. The findings revealed the potential of IPD to drive systemic change within the construction industry, particularly by fostering a culture of collaboration, transparency, and openness to exchange and knowledge sharing across disciplines and cross-organizations. Additionally, IPD has a notable influence on accelerating the adoption and integration of lean practices and tools at the organizational level. These findings highlight IPD's role in reshaping organizational practices, exceeding its transformative role in project delivery dynamics and exemplifying the principles of Innovation Diffusion Theory. This study contributes to understanding IPD's transformative

influence and offers practical insights for industry leaders seeking to optimize project outcomes through collaborative delivery models

Keywords: Integrated project delivery (IPD), Diffusion Dynamics, Organizational Practices, Ripple Effect

INTRODUCTION

Integrated Project Delivery (IPD) is a collaborative delivery system that has the potential to reshape the construction industry landscape by fostering a paradigm where collaboration, transparency, and mutual trust replace the traditional adversarial and competitive norms (Matthews & Howell, 2005). This innovative approach integrates people, organizations, and systems into a cohesive unit under a multi-party contract, promising a favorable work environment and improved project outcomes (Kent & Becerik-Gerber, 2010).

Documented case studies on IPD show evidence of individuals frequently mentioning instances where IPD has promoted a change in how their organizations operate, sometimes in the form of adopting tools, practices, strategies, or changing the way they approach projects and partners and extend these benefits across non-IPD projects as well (Cheng & Johnson, 2016; Poirier et al., 2022) . These instances underscore the diffusion of IPD as an innovative practice within organizations, aligning well with the tenets of Innovation Diffusion Theory (IDT). By focusing on how IPD principles and practices are adopted and integrated within organizational frameworks, this study leverages IDT to examine the transformative impact of IPD on the construction industry.

BACKGROUND

The collaborative nature of this delivery model enhances integration of key stakeholders early in the project which can optimize project efficiency and outcomes (Fischer et al., 2017). When examined through the lens of Innovation Diffusion Theory (IDT), developed by Everett Rogers (ROGERS et al., 2008), IPD can be considered as an agent of change in the construction industry. IPD's transformative characteristics align with the core attributes (advantages, compatibility, complexity, friability, and adoption) that influence the adoption and diffusion of innovations within industries (Elghaish et al., 2021). These transformative characteristics foster collaboration, risk-sharing, and efficiency by integrating owners, designers, and contractors early in the project lifecycle. Unlike traditional delivery methods (Design-Bid-Build, Design-Build), IPD leverages multi-party agreements, shared financial incentives, and advanced digital tools like BIM to enhance transparency and optimize decision-making (Lahdenperä, 2012). Its lean principles reduce waste, improve cost control, and accelerate project timelines, making it highly compatible with the growing demand for sustainable and high-performance buildings (Rankohi et al., 2022).

According to DRENȚA & LOBONȚIU (2016), *relative Advantage* in the IDT, is defined as the degree to which an innovation is perceived as better than the existing standard. Compared to traditional project delivery methods, IPD offers advantages such as improved cost control, reduced waste, and enhanced collaboration (Choi et al., 2019). It fosters value-based decision-making rather than adversarial contract-based interactions, making it a superior approach for complex projects. *Compatibility* refers to the degree to which an innovation aligns with existing values, past experiences, and needs of adopters. IPD is compatible with the increasing demand for collaborative, lean, and sustainable construction practices. It aligns well with digital transformation trends (e.g., Building Information Modeling (BIM)) and with industry shifts towards integrated and agile workflows (Elghaish et al., 2021; Rankohi et al., 2022). *Complexity* refers to the perceived difficulty of understanding and using an innovation. The complexity of IPD can be a barrier to adoption, as it requires a cultural shift from traditional contract-driven roles to trust-based partnerships (Hall et al., 2022). Legal and contractual frameworks (e.g., multi-party agreements) also increase initial complexity. However, organizations that invest in training and knowledge-sharing can overcome these challenges (Hamzeh et al., 2019). *Trialability* refers to the extent to which an innovation can be experimented with on a limited basis. Successful IPD projects (such as healthcare and large-scale infrastructure projects) serve as case studies demonstrating cost savings, reduced disputes, and schedule efficiency (Kelly et al., 2020). As more stakeholders witness the benefits, it accelerates industry-wide diffusion. Partial *adoption* (e.g., employing collaborative principles without full contractual IPD) allows firms to gradually experiment with aspects like early contractor involvement (ECI), co-location of teams, and shared risk-reward mechanisms before full-scale adoption (Koolwijk et al., 2020).

METHODOLOGY

This study aimed to explore the influence of IPD on broader organizational practices through the lens of Innovation Diffusion Theory. To achieve this, the research methodology directly interacted with professionals experienced in IPD from organizations that have implemented this project delivery method. By employing a Mixed-Method Sequential Design, the study combined survey data collection with follow-up interviews to gain an in-depth understanding of how IDT principles such as relative advantage, compatibility, complexity, trialability, and observability manifest in the adoption and integration of IPD. This approach helps illustrate how IPD, as an innovative practice, permeates organizational culture, structure, communication, decision-making, and resource allocation. The mixed-methods sequential design is especially suitable for capturing both broad patterns and in-depth insights. In particular, it combines quantitative and qualitative approaches sequentially, allowing the researcher to integrate different perspectives, ensuring comprehensive data collection, and applying triangulation to enhance the validity and depth of findings (McKim, 2017).

Data Collection and Analysis

Survey Phase

The first phase involved a structured survey designed to capture insights into the organizational impacts of IPD implementation. It consists of three sections: Demographics, that included background data about the individuals, their IPD experience, and their organizations were collected. IPD adoption and participation, which is designed to determine level to which organizations are involved in the IPD projects and their experience with the methodology. Lastly, the Impact on Organizational Practices, which focused on how IPD influences different organizational practices.

Of the total 78 responses received, only 25 fit the criterion of having experiences with IPD and, therefore, are valid for analysis. This sample included participants from various sectors within the construction industry, spanning multiple organizational types and operational scales, as illustrated in **Table A III.** This demographic distribution highlights a diverse and balanced sample of individuals and organizations involved in IPD and braces the conclusions that can be drawn from their responses.

Table A III.1 Demographic Information

Demographic Aspect	**Statistics**
IPD Experience	Moderate Familiarity (40%), High Familiarity (24%), Extensive Experience (36%)
Sectors	Engineering/Design Firms (29%), Subcontractors (24%), General Contractors (18%), Owners/Clients (18%), Facilitating/Consulting Firms (11%)
Geographic Presence	Regional (59%), National (29%), International (12%)
Project Types	Commercial (52%), Institutional (48%), Infrastructure (36%), Residential (36%), Industrial (36%)

In terms of data analysis, Descriptive statistical analysis was performed to comprehend the survey data. Descriptive statistics summarize data in an organized manner by describing the relationship between variables in a sample or population (Kaur et al., 2018). This included calculating frequencies and distributions on key variables relating to IPD's impact on organizational practices. The responses to open-ended questions were analyzed qualitatively to contextualize the results from the quantitative survey.

Interview Phase

Following the survey, seven semi-structured follow-up interviews were conducted with survey respondents. These interviews allowed further investigation into the responses of the preliminary survey and explored nuances in how IPD practices diffuses to organizational level (Creswell & Clark, 2017). The interview participants were sampled from the survey respondents who opted in for follow-up interviews, stating their willingness to provide more detailed insights about their experience with IPD.

An overview of the interviewees' profiles is given in **Table A III.**2, highlighting their roles as top management individuals, their organizations' distribution across three different Canadian provinces, and the diversity of their organizational types.

Table A III.2 The Interview Participants' Profiles

Interview ID	**Role**	**Sector**	**Organization Type**	**Location**
FI01	Project Executive	Private Sector	General Contractor	Ontario
FI02	Director	Private Sector	Consulting Firm	British Columbia
FI03	Managing Principal	Private Sector	Architecture Practice	Ontario
FI04	Director	Public Sector	Municipality	Ontario
FI05	Director of IPD	Private Sector	Electrical Contractor	Alberta
FI06	Lean Integration Leader	Private Sector	General Contractor	British Columbia
FI07	President & Senior Coach	Private Sector	Multidisciplinary Firm	Alberta

The interviews focused on themes identified in the survey and the possible effect of IPD on their organizational practices. The interview transcripts were subjected to thematic analysis, following a systematic coding, categorizing, and theme development process (Clarke & Braun, 2017). In the first step, each transcript was reviewed to identify recurring ideas, terms, and concepts, resulting in identifying a set of initial codes that were then going through a process of eliminating duplicates, merging, and refining. In the second step, related codes were grouped into categories reflecting broader patterns. Finally, categories were synthesized into overarching themes, presenting the study's main findings. Emerging themes were cross-checked against the survey findings to ensure coherence and reliability.

Validation

Triangulation served as the primary validation strategy for this research. This was through the triangulation of data between the survey and interviews, enhancing the validity of the conclusions drawn (Heale & Forbes, 2013). Moreover, the diversity of participants in terms of roles, types of organizations, and geographical locations further enhances the general validity of the findings. It ensures that the conclusions apply to various contexts within the construction industry.

RESULTS

This study examines how IPD diffuses as innovation within organizations, exploring its manifestation across various organizational practices. The results, drawn from both surveys and interviews, are analyzed through the lens of Innovation Diffusion Theory, illuminating systematic changes within organizational structures and processes. The survey results provide a high-level overview, highlighting the areas where IPD has more pronounced effects and establishing the relative prominence of its influence. On the other hand, the interviews offer deeper insights, presenting detailed characterizations of IPD's influence in specific areas. Together, these methods provide a detailed perspective on IPD's diffusion across organizational practices.

Patterns of Influence

The findings highlight that IPD's degree of influence differs significantly across organizational aspects, as illustrated in **Table A III.**3. Among the ten organizational practices examined, organizational culture, tools and practices, communication, learning and knowledge transfer, and organizational structure were the most influenced by IPD.

Table A III.3 Survey Findings on IPD's Influence on Organizational Practices

Organizational Practices	**Observed Changes**	**No Changes Observed**	**Uncertain or Not Applicable**
Organizational Culture	92%	4%	4%
Tools and Practices	61%	39%	0%
Communication	52%	32%	16%
Learning and Knowledge Transfer	52%	24%	24%
Organizational Structure	44%	52%	4%
Resource Allocation	36%	40%	24%
Procurement and Supply Chain	28%	40%	32%
Performance Measurement	28%	44%	28%
Decision-Making Processes	24%	56%	20%
Risk Management	16%	52%	32%

Interestingly, 92% of survey respondents observed positive changes in organizational culture, citing improved collaboration, increased job satisfaction, and a culture of continuous improvement. Enhanced communication strategies were reported by 52% of respondents, characterized by more open and flexible communication strategies that leverage new technologies such as SharePoint, MS Teams, and online applications to break boundaries and facilitate inclusive communication. Similarly, 52% reported enhanced knowledge transfer, particularly in facilitating organizational learning opportunities and innovation. Additionally, 61% noted a moderate to significant positive impact of Lean tools, and 50% indicated adoption of these tools at the organizational levels. Lastly, 44% of survey respondents indicated changes in organizational structure, mainly through changes in the management structure and style, where the teams are more empowered to fulfill their duties, and the management style shifts from traditional project management rules to a stewardship-focused and collaborative oversight approach.

In contrast, several aspects of organizational practices demonstrated limited influence from IPD. For example, 56% observed no changes in the indecision-making process, highlighting the persistence of centralized decision-making frameworks. Similarly, 40% reported no changes in procurement practices, attributing this to standardization challenges and individual projects' unique demands. Resource allocation practices also showed limited transformation, with 40% indicating no change and others pointing to only sporadic adjustments, such as increased staffing for IPD projects. Finally, risk management practices and performance measurement and evaluation remained unchanged for 52% and 44% of survey respondents, respectively.

Influence Dynamics

Building on the quantitative foundation provided by the survey, this study deepens its exploration of the diffusion of IPD practices through seven follow-up interviews with top management practitioners heavily involved in IPD projects. These interviews enrich the survey findings by highlighting the diffusion of IPD strategies and their practical application within organizations.

By drawing on the principles of Innovation Diffusion Theory, the interviews reveal how IPD influences and is influenced by organizational practices, demonstrating a reciprocal influence between organizations and IPD practices. This reciprocal relationship highlights that while organizations change because of the IPD experience, they can contribute to the evolution of IPD practices as well. For example, some organizations have adopted the "Big Room" co-location practice to fit their project teams and coordination needs best. These adaptations, in turn, feed back into refining and optimizing its use on IPD projects. In addition, the interviews revealed that organizations with established Lean principles naturally align with IPD, making their involvement in this delivery model more seamless. This pre-existing alignment often enables them to implement IPD without significant structural or cultural changes. For example, companies that had used Lean tools, such as Choosing By Advantages and structured onboarding, also found the practices complementary to the IPD workflows. As a result, these companies integrated IPD as an extension of their operational strategies without significant adjustments.

Understanding this dynamic interplay between the innovation characteristics of IPD and organizational practices serves as a foundation for the following sections that focus on key organizational aspects such as Organizational Culture, Tools and Practices, Communication and Knowledge Transfer, and Management Structure, where IPD's impact has been particularly transformative. These areas highlight the varied facets of IPD's integration into organizational dynamics, showcasing how they exemplify the successful diffusion of this innovative project delivery approach within the border industry practices.

Organizational Culture

One of the most significant influences of IPD at the organizational level is the cultural shift toward a stronger emphasis on collaboration, transparency, and a value-driven approach. This influence consistently came out during the interviews and the survey alike, where the later indicated an 92% observational level of culture change. A key aspect of this shift is the increased emphasis on transparency. Participants noted that open communication and knowledge sharing, supported by shared accountability, have inspired internal changes that enhance organizational transparency and provide greater insight into holistic operations. Moreover, some of the practices utilized in IPD projects, such as sprint planning and plus-deltas, have helped the organizations move into a team-oriented culture, embedding these collaborative behaviors into everyday workflows.

These cultural changes extend beyond divisions directly involved in IPD projects to drive broader organizational transformations, where IPD amplifies collaboration and transparency across divisions. This widespread diffusion across organizational boundaries highlights IPD's role as a catalytic agent for cultural transformation.

Another observed change is the tendency to prioritize collaboration as an organizational strategy, both in project selection and in practices applied across different contract types. This influence for IPD aligns with the view that the commitment to fostering a collaborative culture in IPD projects is crucial in supporting better project outcomes.

The findings revealed that organizations increasingly prioritize projects that offer collaboration opportunities over traditional competitive contracts that often involve adversarial work environments. One participant noted, "No matter what the contract type, we want to work collaboratively and that has been the biggest outcome, regardless of a team member's been on an IPD project or not is we have created this culture Collaboration, and that has been super successful across our organization." This highlights how the diffusion of collaborative norms through IPD becomes ingrained within the organizational fabric over time.

Collaborative readiness and relationship-building over traditional technical evaluations in partner selection is another key shift. Organizations experiencing IPD increasingly prioritize partners who demonstrate collaborative behaviors, reflecting a strategic move toward fostering alignment and trust. This shift extends beyond selection criteria to reshape relationships with subcontractors and stakeholders, transitioning from hierarchical dynamics to more collaborative partnerships. The IPD experience influences and deepens mutual understanding among the stakeholders, aligns processes, and develops stronger and more durable relationships.

Tools and Practices

The integration of IPD and Lean tools into organizational practices represents another aspect of the influence of IPD. Participants mentioned adopting these tools in non-IPD projects after experiencing their effectiveness on IPD projects. Survey results show that 61% of respondents observed integrating specific IPD and Lean tools into their organizations' operations, further amplifying their value beyond IPD-specific contexts. Participants shared examples of these tools. For instance, "Choosing by Advantages" was one effective decision-making tool learned through IPD that has subsequently been used at both the project and organizational levels. One participant mentioned that their organization's decision-making processes now depend on decision matrix templates developed through IPD projects. Similarly, practices such as pull plans, plus-deltas, lookahead schedules, sprint planning, and dashboarding that are intensively used at IPD projects have been incorporated into the organizational tool kit to enhance collaboration and effectiveness. The use of "Conditions of Satisfaction" was also highlighted as a best practice for setting clear and measurable goals, extending beyond IPD projects to other contract types.

In terms of practices, broader IPD practices and strategies such as the "Big Room" have influenced how organizations manage team dynamics and collaboration on non-IPD projects to foster collaboration and promote a team culture. In addition, a tendency to invest in pre-project alignment as an organizational strategy is another face for IPD influence. Participants indicate that their organizations start investing time and effort upfront to ensure that shared values, alignment, and collaborative culture are established among project participants, a factor viewed as critical to successful outcomes in IPD projects. This demonstrates a shift toward more intensive and collaborative pre-project planning.

This broader adoption of IPD and Lean tools demonstrates a tangible example of how IPD principles influence organizational practices. The diffusion of these tools and practices beyond IPD projects underscores, in addition to their effectiveness, the dynamic of the diffusion of IPD, where the 'trialability made within IPD projects demonstrate the benefits of these tools and therefore foster its adoption at the organizational level.

Knowledge Transfer and Communication

Organizational knowledge transfer and communication strategies represent another important influence area for IPD. IPD experiences promote cross-disciplinary information exchange, openness to external knowledge sharing, and the use of more interactive communication methods. This observation is supported by survey data, with 52% indicating changes in communication patterns inside their firms as a result of IPD.

Participants highlighted how IPD practices promote cross-disciplinary knowledge transfer by breaking down professional silos and fostering direct, frequent interactions that enhance team dynamics and support more effective problem-solving across organizational levels. For example, it has become common for team members to reach out to other disciplines for immediate feedback, mirroring the collaborative dynamics of the Big Room. In addition to the internal improvements, IPD strengthens external knowledge sharing with partners. Participants noted that IPD projects have made organizations more sophisticated in sharing information and best practices.

The influence of IPD extends to communication tools, with organizations limiting formal and traditional email-based methods toward real-time, interactive platforms like Teams, SharePoint, Slack, and Trello. These tools have streamlined communication, fostered collaboration, and supported team cohesion. While this shift is not exclusive to IPD influence, these tools' practical application within IPD projects validated their effectiveness and promoted their broader adoption.

Organizational Structure

Experiencing IPD and understanding its principles better by being part of IPD projects has led to few, yet important, changes in organizational structures and management practices. These changes are primarily about driving organizations to align more closely with the collaborative and integrated practices seen in IPD projects. These structural adaptations reflect the diffusion of IPD principles, reshaping traditional hierarchies and roles to better suit innovative, collaborative workflows. These findings were corroborated by 44% of survey participants who reported changes in their organizational structure.

Organizations are increasingly replicating the IPD project team structure in their operations. This includes establishing management frameworks consistent with IPD setups where clear roles and hierarchies are defined from senior management to project management to implementation levels. This structural change indicates an acknowledgment of the effectiveness of the management structure in the IPD project that enables effective coordination and collaboration among different management levels.

Alongside structural changes, organizations are implementing IPD-inspired management strategies that improve internal practices. These strategies encompass tools and processes that promote collaboration, decentralize decision-making, and empower project teams. For instance, one participant mentioned introducing new roles, such as project coordinators and project management assistants, to enhance collaboration and the effectiveness of project management.

Additionally, an important shift in management style accompanies these structural and procedural changes. Organizations are moving away from traditional project management roles to stewardship-focused and collaborative oversight approaches. This includes redefining roles from "project manager" to "project leader" to emphasize collective health, integrated processes, and team alignment.

DISCUSSION

This discussion explores how the principles and practices of IPD impact organizational structures and practices, altering traditional dynamics within the construction industry. The findings will be discussed from two perspectives: in the context of the existing IPD literature and through the lens of Innovation Diffusion Theory to discuss how IPD principles and practices diffuse and, therefore, impact organizational structures and processes.

The influence of IPD, as revealed through both the survey and interviews, underscores a significant transformative impact on organizational practices within the construction industry, notably in areas like organizational culture, communication, learning and knowledge transfer, and acceleration of lean tools adoption. This shift has deeper implications for the construction industry that exceeds just the changing practices. It suggests a movement towards dismantling traditional hierarchical management structures and promoting joint and collaborative management styles. This is evident in organizations that lean toward prioritizing collaborative work opportunities and partnerships that offer collaboration promises. The enhancement of open communication channels and strategies, supported by a deeper trust and understanding among industry participants, suggests that adopting IPD can lead to an environment where knowledge and resources are shared more freely across disciplines and organizations. In addition, a shift in organizational cultures toward a more transparent, collaborative, value-driven approach can lead to a more resilient organizational culture capable of handling challenges more effectively. This shift aligns with the IPD's potential to transform construction industry practices, as noted by Matthews and Howell (2005), who discuss IPD's potential to reshape industry landscapes by replacing competitive norms with collaboration and transparency. At the same time, these findings align with instances shared by Cheng & Johnson (2016) and Poirier et al. (2022), who reported, within the IPD case studies they investigated, many examples where participants frequently mentioned a border influence for IPD exceeded their project boundaries and changed their organizational practices.

On the other hand, areas such as risk management, decision-making, and procurement have experienced the least influence from IPD. This limited impact can be attributed to a commonly cited barrier to IPD adoption, the regulatory and legal barriers, as reported in this resource (Bhonde et al., 2020; Ma et al., 2023). These areas could be regarded as sensitive for organizations within the construction industry, as they often involve legal contracts, risk management, and the decision-making process, where organizations tend to be highly cautious, carefully considering any potential changes before implementation.

From a different angle, exploring the findings through the lens of Innovation Diffusion Theory offers a profound understanding of the mechanisms through which IPD influences organizational practices within the construction industry. In particular, through the characteristics of innovations that affect that adoption and provide a robust framework for analyzing the adoption and diffusion of IPD, such as relative advantage, compatibility, complexity, trialability, and observability.

A critical aspect of IPD's transformative influence is its compatibility with existing organizational values, particularly those pre-aligned with collaborative approaches and lean methodologies. This study's findings suggested that adopting IPD methodologies is significantly easier for organizations already inclined toward lean principles. Such compatibility facilitates a smoother adoption process where organizational structures are receptive to embracing IPD. This echoes the observations made by Rankohi et al. (2022), where the compatibility of IPD with lean methodologies is regarded as a facilitating factor that enables these organizations to integrate IPD practices more seamlessly.

The cultural shifts towards greater collaboration, trust, and transparency, which are fundamental components of IPD's impact, exemplify the 'relative advantage' and 'trialability' of this innovative delivery method. These cultural transformations are often linked to observable benefits, such as enhanced team dynamics and improved project outcomes, highlighting the 'observability' of IPD's advantages and encouraging the ongoing and expanded adoption of IPD principles. These findings align with insights reported by Drenta and Lobontiu (2016) and Kelly et al. (2020), where the "relative advantages" of IPD are experienced and tested at the project level, 'trialability,' before full adoption at the organizational level.

However, areas such as risk management, decision-making, and procurement, which have experienced less pronounced changes, underscore the 'complexity' aspect of Innovation Diffusion Theory (IDT). This complexity indicates that these elements often require considerable adjustments in organizational policies and may not be readily achievable without significant modifications to existing operational frameworks. This challenge does not suggest that other areas experiencing more profound changes due to IPD are less complex but rather emphasizes that innovations may initially present adoption challenges. Over time, continued use and integration of these innovations can lead to greater adaptability, facilitating organizational transformation, as discussed by Lahdenperä (2012).

CONCLUSIONS

The findings of this study reveal that involvement in IPD projects offers more than an opportunity to improve project outcomes; it serves as a catalyst for broader organizational change. The experience of collaborative delivery fosters significant shifts in culture, communication and knowledge transfer, partnership strategies, and operational processes. Nevertheless, the impact of IPD is not uniform across all different organizational aspects, with procurement, resource allocation, decision-making, and risk management showing minimal evidence of IPD influence, thus remaining largely unchanged.

These transformations underscore the potential of IPD to drive systemic change within the construction industry, particularly by fostering a culture of collaboration, transparency, and openness to exchange and knowledge sharing across disciplines and cross-organizations. Organizations engaged in IPD projects increasingly value collaboration, influencing their choices in project and partner selection based on alignment with collaborative principles. Additionally, exposure to lean tools and various collaborative practices within IPD projects accelerates their integration and adoption, in particular, and the integration of innovative tools and methods in general within the construction industry. Examining these organizational changes through the lens of Innovation Diffusion Theory highlights how IPD acts as an innovation agent within the construction industry, facilitating the adoption and diffusion of new practices and technologies. However, the IPD adoption rates within the industry as a project delivery system would determine whether those shifts driven by IPD can be widely diffused.

This study experienced some limitations, particularly in data collection, data analysis, and sample size. The data collected were geographically limited to Canada, and the number of survey and interview participants was small, which could affect the generalizability of the findings. In addition, there is a potential risk of positive bias in the data, especially given that the participants are highly involved in IPD projects and may have a favorable bias toward IPD.

For future work, studies should aim to expand the geographical coverage by including more locations and markets to enhance generalizability. Additionally, a more thorough investigation into aspects that demonstrated less influence from IPD, such as risk management and decision-making, is necessary. Conducting a longitudinal study that assess the long-term organizational impact of IPD, comparative analyses across different project scales and industries, and the role of emerging technologies such as AI and blockchain in further enhancing IPD's effectiveness. In addition, investigating regulatory and policy adaptations that support widespread adoption of IPD could also provide valuable insights and opportunities.

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APPENDIX A

IPD MATURITY MATRIX – CHAPTER 3

Table A A.1 IPD Maturity Matrix

Capability Set	#	Capability	Level 1	Level 2	Level 3	Level 4	Level 5
			Initial	**Defined**	**Managed**	**Proficient**	**Advanced**
Competency Set 1: Understanding and Facilitation	**1.1**	**IPD Comprehension**	Limited awareness of IPD principles, processes, and key success factors.	Demonstrates familiarity with IPD principles and processes and understands their relevance to project success.	Possesses a solid understanding of IPD principles and processes, actively beginning to integrate and apply these concepts in the project's execution.	Possesses an in-depth understanding of IPD principles and processes and effectively implements IPD strategies and practices across the project.	Exhibits advanced comprehension of IPD principles, processes, and drivers for success, allowing them to adapt and refine IPD practices based on project needs.
	1.2	**Facilitation**	Facilitation processes are not well-established and may not address team needs adequately within the IPD framework.	Facilitation processes are being developed and are beginning to address the fundamental needs of the team in terms of general knowledge about IPD and its processes and stages.	Established facilitation processes are in place, providing necessary knowledge about IPD and its processes, in addition to any needed training on the tools and techniques that will be applied during the project.	Effective facilitation techniques are employed, addressing the team's specific needs (or knowledge gaps) based on thorough assessment and training the team on achieving a collaborative IPD project environment.	Innovates in facilitation practices and training to equip the team with the knowledge, latest methods, and tools to be most effective and contribute to establishing a favorable culture.

Table A A.1 IPD Maturity Matrix (continued)

Capability Set	#	Capability	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Proficient	Level 5 Advanced
	1.3	**Building and Sustaining Teams**	Efforts and resources invested to establish a unified and cohesive team culture are limited.	Attempts to build a cohesive team culture are emerging, with steps to reduce hierarchy and encourage open communication.	Continuous efforts and plans to establish a cohesive team culture are designated as an integral part of the project activities.	Team-building efforts are prioritized and recognized as one of the key drivers for project success. The project culture is supportaive and encourages participation.	Innovative practices are in place to foster a cohesive culture and unity, leading to an exemplary team environment that enhances ownership and encourages active participation and collaboration.
Competency Set 2: Goal Setting and Contract Development	2.1	**Developing Project Goals (Validation Process)**	The validation process is unstructured and conducted with limited collaboration. The validation report is unclear and lacks detail.	Initial efforts at structuring the validation process are visible, with some collaboration among team members beginning to take shape. The validation report is basic and lacks clarity and depth.	The validation process is effectively conducted, with clear project objectives, base target costs, and schedules established through collaborative efforts. Provides a clear validation report and results.	The validation process is highly efficient, detailed, and collaborative, resulting in precise project objectives, costs, and schedules. Delivers a detailed and structured validation report for owner assessment.	The project team excels in the validation process, demonstrating innovation and leading to an insightful validation report that aids owner decision-making. Effectively uses the validation phase to seed and enhance a collaborative project culture.
	2.2	**Defining project values**	The project values are not defined or unclear. The project team has limited understanding and awareness of these values, and they are not referred to in the decision-making process.	Project values are identified but not fully integrated into project processes. There's an emerging effort to communicate these values to the team, though reference to them in decision-making is limited.	Core values are clearly defined and communicated across the project. The values are frequently referred to in the decision-making processes; however, their application is inconsistent.	Project values are clearly defined and consistently applied in the decision-making processes. The project team frequently does values checks to ensure consistent commitment and alignment.	The project values are clear and deeply integrated into the project's operations and decision-making processes. The team adopts innovative methods to reinforce values and ensure their active influence on the project’s culture and outcomes.

Table A A.1 IPD Maturity Matrix (continued)

Capability Set	#	Capability	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Proficient	Level 5 Advanced
	2.3	**Contract Formulation**	Contract formulation lacks true collaboration. Some IPD elements, such as liability waiver, are absent.	Contract formulation is done somewhat collaboratively. Main IPD principles are incorporated into the contract.	Contracts are formulated through a collaborative process with the active participation of all stakeholders. The contract fully integrates IPD principles.	Contract formulation is highly collaborative, leveraging advanced techniques such as workshops and expert consultations. The contract reflects a true IPD project with all its features.	The contract formulation process is highly collaborative, featuring signs of innovation, with attempts to go beyond standard IPD contracts to enhance stakeholders' collaboration and optimize contract terms to precisely reflect the project conditions.
Competency Set 3: Project Governance	3.1	**Defining Roles and Responsibilities**	Limited understanding of individual and collective roles within the project. Roles are not clear, overlapping, and in some cases conflicting, which affects team synergy.	Awareness of roles begins to form. Efforts are made to include all parties in discussions on roles and responsibilities, with leading roles for individuals with prior experience with IPD.	Roles and responsibilities are clearly defined and communicated, emphasizing the importance of each member's contribution to project success.	The team adopts a new entity mindset and deeply understands their interconnected roles, accountability structure, and how they contribute to the project's success.	Roles and responsibilities, accountability structure, and unique contributions of each party to the project's success are deeply understood, allowing for flexibility and adaptability in roles. This enables the team to adjust roles as needed to ensure project success.
	3.2	**Establishing Decision-Making Process**	The decision-making process is made with limited transparency and collaboration and with limited guidance from project goals and values.	The team begins to establish a decision-making process that is guided by project goals and values. However, the process does not include all team members, and documentation is inconsistent.	A collaborative decision-making process is in place, with team members actively participating in open discussions that lead to decisions grounded in shared project values. Decision matrices and other tools are employed to evaluate alternatives, with most decisions being well-documented.	Decision-making is highly inclusive and reflective of the project's joint management approach. Effective use of tools like decision matrices to assess alternatives, alongside thorough documentation of decisions' context and rationale.	In addition to inclusivity, transparency, collaboration, and thorough documentation, the decision-making process is characterized by adaptability, agility, and responsiveness to evolving project needs.

Table APPENDIX A.1 IPD Maturity Matrix (continued)

Capability Set	**#**	**Capability**	Level 1 **Initial**	Level 2 **Defined**	Level 3 **Managed**	Level 4 **Proficient**	Level 5 **Advanced**
	3.3	**Establishing Management Structure**	The management structure is undefined or poorly organized. Lack of coordination among SMT, PMT, and PIT leads to confusion and inefficiencies, impacting project flow.	Initial efforts to establish a structured management framework are in place, improving communication between management levels. However, these structures are not fully optimized, resulting in some operational inefficiencies.	A clear management structure is established, with distinct roles and responsibilities across the management levels (SMT - PMT - PIT). This structure enhances project coordination, effective decision-making, and project progression. The PMT does most of the project work, with limited roles for the SMT and PITs.	The management structure operates efficiently and is marked by highly coordinated efforts between SMT, PMT, and PIT, each with a distinct role that is performed entirely to ensure smooth project execution. The PMT performs as the operational core, driving most project activities. The SMT plays a supervisory and conflict-resolution role and stays continuously informed and engaged. PITs are active as multidisciplinary teams handling specific project areas with expertise.	The management structure operates with full efficiently and is characterized by adaptability to the project needs and innovation in management practices to boost collaboration and efficiency across SMT, PMT, and PIT.
	3.4	**Owner involvement**	Owner involvement is minimal, with little engagement in daily management or decision-making.	The owner begins to take a more active role, though involvement is still limited to key decisions or milestones.	The owner is actively involved in project governance, contributing to decision-making and supporting the IPD approach.	The owner plays a central role in project governance, fully embracing the IPD model and contributing to its success through active participation and leadership.	The owner is the actual leader of the project and the primary champion of IPD. Their involvement is transformative, where they drive the project forward with a deep commitment to IPD principles, fostering collaboration, and creating a distinct team culture.

Table A A.1 IPD Maturity Matrix (continued)

Capability Set	#	Capability	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Proficient	Level 5 Advanced
Competency Set 4: Operational Excellence	4.1	**Operational Culture**	The operation culture is primarily traditional, and no efforts are made to encourage a shift towards Lean thinking, collaborative work, and a no-blame culture.	Efforts and initiatives to shift from traditional practices to a Lean and collaborative culture, including adopting a no-blame culture, are emerging, and their importance is increasingly recognized.	Determinate and continuous efforts are in place to promote a Lean, collaborative, and no-blame culture. Various practices are implemented and regularly assessed for effectiveness.	A lean and collaborative culture, underpinned by a no-blame environment, is well-integrated into the project's daily activities and significantly influences its operations.	The team fully embodies a Lean and collaborative culture, with a solid commitment to a no-blame culture that drives ongoing innovation in practices and implementation.
	4.2	**Operational Principles**	Integrating Lean design and construction principles with IPD principles into the project operations is minimal.	Lean design and construction and IPD key principles are starting to be integrated into the project process, and there is growing recognition of their importance for project success.	Key Lean design and construction and IPD principles are effectively applied, and their influence on project operations is visible.	Lean design and construction principles are fully integrated into IPD processes. The project's operational activities are driven by Lean principles, focusing on streamlining workflows, reducing waste in methods and materials, and maximizing value.	Lean design and construction principles are an essential part of the project management approach and have a tangible influence on project efficiency with notable innovation and continuous improvement in the application.
	4.3	**Tools**	Basic use of BIM for visualization without integration of Lean tools, with no substantial contribution to project coordination or collaboration.	BIM is integrated into the project for basic coordination tasks such as clash detection, but its full collaborative potential remains largely untapped. Utilization of lean tools is limited to planning tools such as pull planning and the last planner.	BIM is effectively utilized, directly enhancing project coordination and collaboration. The model is collaboratively developed and regularly updated. A wider range of Lean tools, such as pull planning, last planner, plus/delta, and target value design, are being used.	BIM is a central element of the project management strategy, facilitating advanced project coordination and communication and significantly improving workflow. Lean tools are extensively applied, streamlining workflows and reducing waste in processes and materials.	BIM facilitates advanced project coordination and communication, provides a verified source of information in the project, and is characterized by driving innovative practices. Lean tools and techniques are the core of the project's operational practices, significantly influencing project efficiency.

Table A A.1 IPD Maturity Matrix (continued)

Capability Set	#	Capability	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Proficient	Level 5 Advanced
	4.4	**Dynamics**	Multidisciplinary team integration is minimal, with limited inclusivity. Teams are initially formed and remain fixed throughout the project, with no adaptability to project needs.	Teams include a broader range of participants. There is minimal adaptability in team formation based on project demands, and teams take limited responsibility for tasks.	Multidisciplinary teams are fully inclusive. There is emerging flexibility in forming teams as project needs arise, and they are given clearer responsibilities.	Multidisciplinary teams operate with high efficiency and are fully adaptable to project needs. They are empowered to manage their tasks comprehensively.	Multidisciplinary teams are highly effective, fully adaptable, and seamlessly integrate all relevant disciplines and stakeholders. Their work is central to the project's success, driving innovation and efficiency through true integration.
	4.5	**Engagement**	Communication is predominantly formal, confined mostly to emails and paper documents. There is minimal effort to facilitate and enhance active engagement.	Begins to expand beyond formal correspondence with more exchange channels, such as big-room meetings, facilitating greater stakeholder engagement.	Effective, routine communication and engagement practices are well-established. Active participation from all team members is evident, supported by both structured communication protocols and informal channels, such as collaboration platforms.	Communication and engagement strategies are effective and inclusive, including the on-site team to keep them in the loop and aligned with the project's culture and objectives. Engagement features the appropriate use of tools, including various digital communication means.	Innovates in communication and engagement strategies that facilitate communication and active participation, reflecting a superior collaborative culture.
	4.6	**Work Environment**	Initial use of Big Room. Infrequant meetings are occurring (physical or virtual) with minimal impact on project collaboration.	Frequent Big Room meetings occur (physical or virtual). Meetings are primarily traditional in format, with limited impact on team collaboration and culture.	Big Room sessions are frequent and tailored to maximize team interaction. The meeting spaces are arranged to encourage open dialogue, and sessions include all team members and featured by being highly collaborative and productive.	Big Room sessions are integral to the project's workflow. Sessions include advanced setups that promote superior collaboration and inclusivity. Cultural practices such as equal seating and a no-title zone are evident, enhancing team unity and engagement.	Innovative approaches in Big Room facilitation regarding accommodations and tools. The dominant culture reflects a true unity and harmony that masters collaboration and engagement.

Table A A.1 IPD Maturity Matrix (continued)

Capability Set	#	Capability	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Proficient	Level 5 Advanced
Competency Set 5: Management and Oversight	5.1	**Information Management**	Information sharing is not structured and is often paper-based, with little to no integration of digital tools.	Establishes basic protocols for data management that support the needs of IPD projects. Begins to enhance information accessibility and organization to facilitate better collaboration.	Manages a structured flow of information, offering enhanced data accuracy and real-time access to all project members, facilitated by digital tools like BIM.	Advanced information management systems are fully integrated, providing comprehensive data access and utilization across platforms, supporting collaborative practices and decision-making.	Innovate in information management within IPD projects, with the use of cutting-edge technologies such as AI, digital twins, and VR that are employed to enhance data utilization and collaborative decision-making.
	5.2	**Financial Practices**	Limited engagement in collaborative financial practices. Financial activities are mostly siloed with minimal transparency, and there are no incentive mechanisms to sustain collaboration through out the project phases.	Recognizes the benefits of collaborative financial practices and start to implement open-book accounting. Efforts to involve team members in financial discussions are underway, fostering a culture of shared financial responsibility. Incentive mechanisms are introduced but are in early stages.	Regularly integrates team members in financial decision-making, ensuring financial transparency and shared responsibility. Incentive mechanisms are in place but need further refinement to effectively sustain team collaboration throughout the project.	Team members are fully integrated in financial decisions, with highly transparent operations and established practices of shared responsibility and individual accountability. Incentive mechanisms are well-defined and strategically designed to sustain collaboration throughout the project phases.	Demonstrates innovative strategies and tools to integrate team members in financial decision-making with a mature culture of shared financial responsibility and solid individual accountability. The incentive mechanisms are sophisticated, effectively maximizing team performance and fostering sustained collaboration.
	5.3	**Risk Practices**	Initial steps are taken to collaboratively identify risks using shared tools like risk registers. Awareness of collective risk management practices is emerging among team members.	Regular use of collaborative tools such as risk registers to identify and assess risks. Team members start to actively engage in joint mitigation efforts and establish clear roles in risk ownership.	Routinely conducts comprehensive risk assessments collaboratively. Strategies for risk mitigation are collaboratively developed and implemented, demonstrating a mature understanding of shared risk ownership.	Advanced integration of risk management practices, with all team members actively using and updating risk management tools like risk registers. Collective ownership of risk mitigation processes is well-established, with proactive strategies effectively minimizing risks.	Risk management processes are innovative and fully integrated into every phase of the project, with exceptional team engagement and a strong culture of collective risk ownership.

Table A A.1 IPD Maturity Matrix (continued)

Capability Set	#	Capability	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Proficient	Level 5 Advanced
	5.4	**Performance Monitoring**	Basic data collection is in place with minimal integration. There is little to no use of unified data forms or dashboards.	Project dashboards are introduced, visualizing basic performance metrics like budget and schedule adherence. Efforts are made to standardize data collection, but comprehensive integration is lacking.	Regular use of project dashboards that track a broader range of metrics, such as safety and culture, tailored to the specific needs of the project. Data from various project members starts to be unified, enhancing the accuracy of performance reviews.	Comprehensive integration of performance metrics into regularly updated dashboards that facilitate decision-making and prompt resolution of emerging issues. Metrics are fully unified across all project disciplines, providing a holistic view of the project status.	Innovates in performance monitoring practices. Employing a Cutting-edge tools and technologies that allow real-time data to be integrated into sophisticated dashboards offer comprehensive insights into all critical project aspects and drive continuous improvement.
Competency Set 6: Continuous Learning	6.1	**Continuous Learning and Improvement**	Recognizes the need to capture lessons learned but lacks a formal process with minimal systematic analysis.	Begins to implement structured processes for gathering lessons learned, including basic tools for capturing feedback on IPD practices, client satisfaction, and stakeholder feedback.	Regularly gathers and analyzes lessons learned using established methods. Information from projects is systematically collected and reviewed. Initial steps are taken to integrate findings into project planning and feedback loops.	Effectively capture, analyze, and share lessons learned. Practices are well-integrated, with clear protocols for using feedback to refine project practices.	Innovate in techniques and tools utilized in lessons-learned practices for continuously capturing, analyzing, and applying insights to improve IPD practices and outcomes.

APPENDIX B

INTERVIEW PROTOCOL – OWNER / THREE CASE STUDIS – CHAPTER 2

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ÉTS ÉCOLE DE TECHNOLOGIE SUPÉRIEURE

Study on the factors leading to successful IPD in Canada (Owner Interview)

The University of British Columbia (UBC, Vancouver, BC) and École de technologie supérieure (ETS, Montreal, Qc) are conducting a research project, sponsored by the Integrated Project Delivery Alliance (IPDA), which aims to investigate the adoption of Integrated Project Delivery (IPD) in Canada. This study aims to better understand the factors that lead to success and specifically focus on investigating how and why is IPD effective, particularly in the Canadian context.

Over the course of this project, the research team will be collecting data, namely interviews, surveys, and documents. The interviews will be conducted in group settings, primarily using online meetings and teleconferencing platforms. These interviews will be audio/video recorded.

The data collected **will only be accessible to the research team from UBC and ETS involved in this project**. The collected data will be stored at UBC and ETS, archived safely and securely, in a secure and encrypted database. All participants information will be anonymized. All data will be kept for a maximum of 10 years for research ends, following which they will be destroyed.

Q1. Please describe your business and its overall strategy.

Q2. What is the appetite of your organization for risk? What role did risk play in the choice of IPD as a delivery mode?

Q3. Can you talk to us about your past experience with capital projects? How did that experience influence the way in which you approached this project?

Q4. Why did your organization choose to pursue IPD on this project?

Q5. What is your organization's view on setting capital costs for its projects? (lowest cost, best value, etc.)

Q6. What were the initial metrics developed to track the project? How were they tied to your business objectives? Did these metrics evolve?

Q7. What were the project goals? How were they communicated to the project team? Were they met?

Q8. Please tell us about any liability waivers or special insurance (or other) that were needed on the project.

Q9. Please tell us about the team selection process.

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Figure A B.1 Interview Protocol - Owner

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Q10. Please tell us about the contract and how it was negotiated. Were there parts that worked well? Some that didn't work as well?

Q11. Was the number of signatories adequate?

Q12. How did the contract contribute to the project's success?

Q13. Please tell us about the financial aspects of the project.

Q14. Was there fiscal transparency between contract parties? Was it required by contract? How was transparency ensured? What impact did this have on the project?

Q15. Please tell us about how the project team collaborated?

Q16. What resources (how much time and who) were budgeted for by your organization for the project? Was that sufficient?

Q17. Please describe the validation process? (What were the challenges, was it successful, etc)

Q18. Please describe how Lean was used on this project. What are your lessons learned?

Q19. Please tell us about the work environment (co-location, Big Room) How did the pandemic impact this?

Q20. Please describe how BIM was used on the project. How successful was it? What were the challenges?

Q21. Please tell us about the on-boarded and off-boarding process. Did you have to remove anybody from the project?

For more information, you can contact the co-investigator : erik.poirier@etsmtl.ca .

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Figure A B.1 Interview Protocol – Owner (continued)

APPENDIX C

INTERVIEW PROTOCOL – TEAM / THREE CASE STUDIS – CHAPTER 2

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ÉTS Engineering for Industry — ÉCOLE DE TECHNOLOGIE SUPÉRIEURE Université du Québec

Study on the factors leading to successful IPD in Canada (Team Interview)

The University of British Columbia (UBC, Vancouver, BC) and École de technologie supérieure (ETS, Montreal, Qc) are conducting a research project, sponsored by the Integrated Project Delivery Alliance (IPDA), which aims to investigate the adoption of Integrated Project Delivery (IPD) in Canada. This study aims to better understand the factors that lead to success and specifically focus on investigating how and why is IPD effective, particularly in the Canadian context.

Over the course of this project, the research team will be collecting data, namely interviews, surveys, and documents. The interviews will be conducted in group settings, primarily using online meetings and teleconferencing platforms. These interviews will be audio/video recorded.

The data collected **will only be accessible to the research team from UBC and ETS involved in this project**. The collected data will be stored at UBC and ETS, archived safely and securely, in a secure and encrypted database. All participants information will be anonymized. All data will be kept for a maximum of 10 years for research ends, following which they will be destroyed.

Q1. Can you please tell us how this project compares to past projects that were of similar scope and type?

Q2. Please tell us about contract negotiation process. At what point in the project did it happen?

Q3. Please tell us about the goal setting process.

Q4. Were the owner's goals clear from the onset? Did they evolve throughout the project?

Q5. Please tell us about any liability waivers or special insurance (or other) that were needed on the project.

Q6. Please tell us about how you got involved in the project.

Q7. What is your past experience with IPD?

Q8. Please tell us about the RFP process. Who was involved?

Q9. How was IPD championed on the project? Who championed it?

Q10. How did the team measure their success?

Q11. Please describe the validation process? (What were the challenges, was it successful, etc) Please describe the validation report, how comfortable were you with its content?

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Figure A C.1 Interview Protocol - Team

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ÉCOLE DE TECHNOLOGIE SUPÉRIEURE

Q12. How were decisions made on the project? Did this process evolve over the course of the project?

Q13. Please describe how target value delivery/target costing was used on the project, were targets met?

Q14. How reliable was project forecasting? (resources, budgets, etc)

Q15. Please describe how BIM was used on the project. How successful was it? What were the challenges?

Q16. Please describe the other digital tools and methods used in the project. How were they used to attain project goals?

Q17. What metrics did you use to measure team effectiveness? Building outcomes?

Q18. How were you and your team members on-boarded onto the project and off-boarded?

Q19. How was team cohesion maintained on the project?

Q20. To what extent did the project satisfy the fiscal goals of the project team?

Q21. Please tell us about fiscal transparency between contract parties? Was it required by contract? How was it ensured?

For more information, you can contact the co-investigator : erik.poirier@etsmtl.ca .

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Figure A C.1 Interview Protocol – Team (continued)

APPENDIX D

SURVEY PROTOCOL – THREE CASE STUDIES – CHAPTER 2

Demographics

This study aims to investigate the adoption of Integrated Project Delivery (IPD) in Canada. In addition to understanding the factors that lead to IPD project success and specifically focus on investigating how and why is IPD effective, particularly in the Canadian context.

In the context of this study, you are invited to complete this short survey. Your response to this survey is completely anonymous and will never be linked to you personally. We'd love for you to take 10-15 minutes to tell us about your experience throughout the project that you were participating in. Your experience and responses are extremely valuable.

https://ubc.ca1.qualtrics.com/Q/EditSection/Blocks/Ajax/GetSurvey...tSurveyID=SV_bszobnJhsmBW5zU&ContextLibraryID=UR_vyRVaJKN80xe6D1 Page 1 of 24

Figure A D.1 Survey Protocol

Your participation in this study is entirely voluntary, and you may refuse to participate or withdraw from the study at any time without any repercussions to you.
Your agreement indicates that you consent to participate in this study and implies that you accept that the research team is allowed to use the data collected for research purposes and dissemination (in articles, conferences and scientific communications). Please note that in the case of dissemination, any information that could identify you or the company you work for (pictures, clips or other) will not be revealed to the public nor be made publicly available unless an explicit prior agreement has been enforced info.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethicsat 604-822-8598 or if long-distanceemailRSIL@ors.ubc.caor call toll free 1-877-822-8598.

○ Agree ○ Disagree

Figure A D.1 Survey Protocol (continued)

Q1. What is the name of your firm?

Q2. What is the name of your the project?

Q3. What is the role you associate with?

- ○ Executive
- ○ Project Manager
- ○ Supervisor
- ○ Trade
- ○ Technician
- ○ Consultant

Q4. Please select the project phases you were involved in

- ☐ Project planning
- ☐ Team selection

Figure A D.1 Survey Protocol (continued)

- ☐ Validation
- ☐ Detailed design / Implementation
- ☐ Buy-out
- ☐ Construction
- ☐ Handover
- ☐ Operations

Context

Q5.
How familiar were you with the following parties, prior to working on this project (either through previous working experience, reputation or shared professional network)?

	Not familiar at all	A little familiar	Familiar	Very familiar	Long-term partner	N/A
Owner company	○	○	○	○	○	○
Architect company	○	○	○	○	○	○
General Contractor company	○	○	○	○	○	○
Trade Partner companies	○	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

Members on your own team	○	○	○	○	○	○

Q6. What was your previous experience with:

	First time working with	2-3 projects	More than 3 projects	N/A
IPD	○	○	○	○
Lean	○	○	○	○
BIM	○	○	○	○

Q7. What was the level of collaboration between owner, designers and builders, for scope development on this project?

Very little	Little	Some	High	Very High	Don't Know
○	○	○	○	○	○

Q8. How would you describe communication with the owner and his representative?

Very Very

Figure A D.1 Survey Protocol (continued)

opaque	Opaque	Neutral	Clear	Clear	N/A
○	○	○	○	○	○

Q9. To what extent did shared savings incentivize collaboration among the project parties?

Significant negative impact	Negative impact	No Impact	Positive impact	Significant positive impact	Don't Know
○	○	○	○	○	○

Leadership & Management

Q10. How would you describe the contribution of the IPD champion to the project's success?

Not at all important	Low	Neutral	High	Very important	Don't Know
○	○	○	○	○	○

Q11.
To what extent were the decisions on this project:

Very little	Little	Some	High	Very high	Don't know

Figure A D.1 Survey Protocol (continued)

Made collaboratively with the right people involved with decision making?	○	○	○	○	○	○
Made in a timely way so that options could be considered?	○	○	○	○	○	○
Reliable and stable, unlikely to be reversed?	○	○	○	○	○	○

Q12. How would you describe the effectiveness of the on-boarding process?

Not effective at all	Little effective	Somewhat effective	Effective	Very effective	Don't Know
○	○	○	○	○	○

Q13. How clear were the owners' goals?

Ambiguous	Somewhat clear	Explicit	N/A
○	○	○	○

Q14. How well were the owner's goals communicated?

Figure A D.1 Survey Protocol (continued)

Not communicated at all	Communicated very rarely and inconsistently	Communicated on an ad hoc basis but somewhat regularly	Communicated on a regular basis and in a consistent manner	Continuously and clearly communicated	N
○	○	○	○	○	(

Processes & Lean

Q15.
How effective was the process of coaching and training on IPD on your project?

Not effective at all	Little effective	Somewhat effective	Effective	Very effective	N/A
○	○	○	○	○	○

Q16. Which of the following tools were used in your project? Check all that apply

- ☐ Last Planner System (including pull planning, PPC, work plans, first run studies)
- ☐ Plus/Deltas
- ☐ A3
- ☐ Dashboards

Figure A D.1 Survey Protocol (continued)

☐ Visual Documentation

☐ Other (please provide details below)

Q17. How you would describe the effectiveness of the tools you have used in your project:

	Not effective at all	Not that effective	Somewhat effective	Effective	Very effective	Don't Know
Last Planner System (including pull planning, PPC, work plans, first run studies)	○	○	○	○	○	○
Plus/Deltas	○	○	○	○	○	○
A3	○	○	○	○	○	○
Dashboards	○	○	○	○	○	○
Visual Documentation	○	○	○	○	○	○
Other (please provide details below) tools	○	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

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Q18. Meetings involving different companies were:

	Never	Rarely	Sometimes	Often	All the Time	Don't Know
fun?	◯	◯	◯	◯	◯	◯
participatory?	◯	◯	◯	◯	◯	◯
successful?	◯	◯	◯	◯	◯	◯
frustrating?	◯	◯	◯	◯	◯	◯
facilitated?	◯	◯	◯	◯	◯	◯
provided with updated documents or models relevant to the discussion?	◯	◯	◯	◯	◯	◯
working meetings where team members attended as needed?	◯	◯	◯	◯	◯	◯
organized with agendas and meeting minutes?	◯	◯	◯	◯	◯	◯

Q19. How do you rate the meeting frequency?

Too many	About right	Too few	Don't know
◯	◯	◯	◯

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Figure A D.1 Survey Protocol (continued)

Q20. How would you describe the effectiveness of lean-implementation and its practices in your project?

Not effective at all	Not that effective	Somewhat effective	Effective	Very effective	Don't Know
○	○	○	○	○	○

Q21. In your experience, how effective was team formation on this project?

Team Formation: includes things like Team Forming and Team Initiation, Experienced Lean Partners, Early Stakeholder Involvement, Team Partner Selection, Hierarchical vs Distributed Leadership, Onboarding Team Members

Not effective at all	Not that effective	Somewhat effective	Effective	Very effective	Don't Know
○	○	○	○	○	○

Q22. In your experience, how effective were the physical/virtual work environment and meetings on this project?

Physical / Virtual Work Environment and Meetings: includes things like Co-location, Big Room, Daily Huddle, Agenda development, Visual Management techniques.

Figure A D.1 Survey Protocol (continued)

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Not effective at all	Not that effective	Somewhat effective	Effective	Very effective	Don't Know
○	○	○	○	○	○

Q23. In your experience, how effective was cost forecasting and management, decision making, and the design process on this project?

Cost, Decision Making, and Design: includes things like Cost Forecasting for Early Project Phases, Collaborative Budget Management, Conceptual and Continuous Estimating, Risk and Opportunity Register, The Shared Risk-Reward Business Deal, Target Value Design, Cluster Groups, Set based design, Choosing by Advantages, A3 Thinking, 5Why, Value Stream Mapping.

Not effective at all	Not that effective	Somewhat effective	Effective	Very effective	Don't Know
○	○	○	○	○	○

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Figure A D.1 Survey Protocol (continued)

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Q24. In your experience, how effective was project planning, management, and accountability on this project?

Project Planning, Management, and Accountability: includes things like Last Planner System of Production Control, Production System Design, Reliable Promising, Hand-off Work Planning, Burn Rate Management, Work Structuring, Noticing and Declaring Breakdowns.

Not effective at all	Not that effective	Somewhat effective	Effective	Very effective	Don't Know
○	○	○	○	○	○

Q25. Did the use of Building Information Models:

	Never	Rarely	Sometimes	Often	All the Time	Don't know
Help the team achieve a shared understanding of the project?	○	○	○	○	○	○
Improve communication among project parties?	○	○	○	○	○	○

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Figure A D.1 Survey Protocol (continued)

Improve communication between facilities management and tenants?	○	○	○	○	○	○

Q26.
How would you describe the extent of BIM use in your project?

- ○ High - extensively used and customized (i.e. all project information developed and communicated through the models)
- ○ Medium - used frequently with most of the known capacity of the tool/process (i.e. project information developed and communicated jointly through the models and through 2D documents)
- ○ Low – used but not extensively and with only some of the power of the tool / process (i.e. project information developed and communicated principally through 2D documents)
- ○ Don't Know

Q27. How extensively were Building Information Models shared among following parties in this project: (Check all that apply)

Continuously accessed through the project's

Figure A D.1 Survey Protocol (continued)

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	Not shared at all	Shared at key milestones	Shared on demand	common data environment	N/A
Project management	○	○	○	○	○
Facility management	○	○	○	○	○
Architect	○	○	○	○	○
Contractor	○	○	○	○	○
Engineers/design consultants	○	○	○	○	○
Trade contractors	○	○	○	○	○
Suppliers	○	○	○	○	○

Q28.
How much did BIM help the project team in:

	No help at all	Helped a little	Helped somewhat	Helped a lot
Identifying and accepting financial risks early in the project development:	○	○	○	○
Meeting the owner's fiscal outlay goals:	○	○	○	○
Overcoming budget complexity:	○	○	○	○
Predicting design schedule	○	○	○	○
Predicting construction schedule:	○	○	○	○

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Figure A D.1 Survey Protocol (continued)

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Identifying and accepting schedule risks early in the project development:	○	○	○	○
Meeting schedule goals:	○	○	○	○
Identifying and accepting design or program risks early in the project development:	○	○	○	○
Identifying and accepting construction risks early in the project development:	○	○	○	○
Meeting the project scope:	○	○	○	○
Meeting the sustainability goals:	○	○	○	○
Producing a high quality building:	○	○	○	○
Innovating compared with regular practice:	○	○	○	○
Better management and operations of facilities compared to similar buildings:	○	○	○	○
Integration with facility operation and management systems:	○	○	○	○
Increased building performance and quality compared to similar buildings:	○	○	○	○
Other benefits (fill in)	○	○	○	○

Q29.

How would you rate the quality of the information found in the model?

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Figure A D.1 Survey Protocol (continued)

- ○ Very high: All the information found in the model was extremely accurate (i.e. precise), reliable (i.e. consistent) and useful
- ○ High: Most of the information found in the model was accurate (i.e. precise), reliable (i.e. consistent) and useful
- ○ Acceptable: Some of the information found in the model was accurate (i.e. precise), reliable (i.e. consistent) and useful, although there were instances where some information (non-critical) wasn't.
- ○ Low: Most of the information found in the model was inaccurate (i.e. not precise), unreliable (i.e. not consistent) and not very useful
- ○ Very low: Most, if not all information in the model was very inaccurate (i.e. not precise), unreliable (i.e. not consistent) and not useful at all.
- ○ Don't Know

Alignment & Goals

Q30. How you would describe the impact of co-location on the following:

	No impact	Low impact	Some impact	Considerable impact	Significant impact	N/A
Building team culture	○	○	○	○	○	○
Reduced paperwork	○	○	○	○	○	○
reduced time for decisions	○	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

Qualtrics Survey Software 2021-06-04, 1:45 PM

Q31. How would you describe the communication between contract parties?

Completely closed / siloed	Had to follow a Specific protocol	Limited	Open	Don't Know
○	○	○	○	○

Q32. How would you describe your level of trust for other contract parties? in general

Very low	Low	Neutral	High	Very high	Don't know
○	○	○	○	○	○

Q33. How successful was the project management team

	Very unsuccessful	Unsuccessful	Neutral	Successful	Very Successful	Don't Know
In leading the team?	○	○	○	○	○	○

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Figure A D.1 Survey Protocol (continued)

In fostering a sense of shared ownership in project success:	○	○	○	○	○	○
In establishing trust among team members?	○	○	○	○	○	○
In removing barriers?	○	○	○	○	○	○

Q34. Over the course of the project, how often did you witness the following happen between members of the project team:

	Never	Rarely	Sometimes	Often	All of the time	Don't know
Taking advantage of partner companies' vulnerabilities:	○	○	○	○	○	○
Understanding of the challenges and obstacles of other companies' scope:	○	○	○	○	○	○
Building of strategic relationships with partner companies:	○	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

Fulfillment of their mutual obligations to each other:	○	○	○	○	○	○
Reliance on formal agreements that spelled out relationships between partner companies:	○	○	○	○	○	○
Expressing of a duty to meet their obligations to partner companies:	○	○	○	○	○	○
Effective communication and highlighting of important information:	○	○	○	○	○	○
Understanding of their own roles and responsibilities in the collaboration:	○	○	○	○	○	○
Belief that the collaboration process would support reaching the project goals:	○	○	○	○	○	○
Reliance on inter-personal relationships with partner companies:	○	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

Open communication of both mistakes and challenges:	○	○	○	○	○	○

Q35. In your experience, to what extent did the following occur with respect to collaboration of the companies in this project?

	Never	Rarely	Sometimes	Often	All of the Time	Don't Know
People could get in touch with others from different companies without any problems.	○	○	○	○	○	○
Companies were transparent in their communication with others on the team.	○	○	○	○	○	○
Communication among partner companies was effective.	○	○	○	○	○	○
There were misunderstandings among companies due to lack of proper communication.	○	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

Building outcomes

Q36. As far as you know, to what extent did the project satisfy the owner's fiscal goal?

	Not at all	Low	Somewhat	High	Completely	N/A
As far as you know, to what extent did the project satisfy the owner's fiscal goal?	○	○	○	○	○	○

Q37. How do you rate your experience on this project against your previous project experience?

The worst of my career	Very Low	Low	About the same	High	Very high	The best of my career	N/A
○	○	○	○	○	○	○	○

Q38.
Identify the likelihood for each of the following statements:

Figure A D.1 Survey Protocol (continued)

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	Very unlikely	Unlikely	Neutral	Likely	Very likely	N/A
On a project of similar type and scope the likelihood I would want to use IPD again is	○	○	○	○	○	○
The likelihood of me wanting to use IPD in general on other projects is	○	○	○	○	○	○
The likelihood of me recommending IPD as a delivery methodology to others is	○	○	○	○	○	○

Q39. On a scale from 1 to 5 (1-very poor, 5- excellent), please rate how you feel the project performed across the following indicators

	1	2	3	4	5
Integration	○	○	○	○	○
Team spirit	○	○	○	○	○
Team culture	○	○	○	○	○
Design documentation	○	○	○	○	○
Design coordination	○	○	○	○	○

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Figure A D.1 Survey Protocol (continued)

Design quality	○	○	○	○	○
Meeting of expectations	○	○	○	○	○
Speed of design	○	○	○	○	○
Speed of construction	○	○	○	○	○
Clarity of contract	○	○	○	○	○
Respect of scope	○	○	○	○	○

Figure A D.1 Survey Protocol (continued)

APPENDIX E

SURVEY– IPD AWARENESS, PERCEPTIONS, AND CHALLENGES – ANNEX II

Participation

You are invited to participate in this research study. After reviewing this document and agreeing to participate, you'll be asked to complete a questionnaire with about fifteen questions about the features of IPD. Filling out the questionnaire is estimated to take between 10 to 30 minutes, based on your responses.

Participation is entirely voluntary, so you're free to opt out at any time. If you wish to stop while filling out the questionnaire, you can simply discontinue answering the questions without providing any reasons. Additionally, you have the option to save your responses and continue completing the questionnaire at a later time.

Reseach team:

Érik Poirier, Professor in the Department of Construction Engineering– École de technologie supérieure | erik.poirier@etsmtl.ca (mailto:erik.poirier@etsmtl.ca)

Ibrahim Abdennoure Mekaoussi, Master's student in engineering project management – École de technologie supérieure

Ahmad Arar, PhD student - École de technologie supérieure

Confidentiality

The data collected for this project will remain confidential, as permitted by law. The lead researcher at the École de Technologie Supérieure will retain this data for a period of 5 years. Its sole use will be for furthering knowledge in the field.

They may be published in reports, articles, be the subject of scientific discussions, or be used for teaching purposes. In none of these cases will it be possible to identify you.

Contacts

Should you have any questions or require further details about the project or your participation, please reach out to the lead researcher, Érik Poirier: erik.poirier@etsmtl.ca (mailto:erik.poirier@etsmtl.ca).

By proceeding, you consent to the terms outlined above

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges

In which domain does your company operate?

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Client
- ◯ Architecture
- ◯ Engineering
- ◯ General contractor
- ◯ Speciality contractor
- ◯ Manufacturer
- ◯ Supplier
- ◯ Other

In which sector does your company operate?

❶ Check all that apply
Please choose **all** that apply:

- ☐ Residential
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Civil engineering and roads

In which region(s) does your company operate?

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Outside Quebec and everywhere within the province
- ◯ Everywhere in Quebec
- ◯ In specific regions of Quebec

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

If your company operates within specific regions of Quebec, please select the relevant regions:

Only answer this question if the following conditions are met:
((G00Q07.NAOK (/questionAdministration/view/surveyid/796787/gid/38/qid/3402) == "AO03"))

❶ Check all that apply
Please choose **all** that apply:

- [ ] Bas-Saint-Laurent
- [ ] Saguenay–Lac-Saint-Jean
- [ ] Capitale-Nationale
- [ ] Mauricie
- [ ] Estrie
- [ ] Montréal
- [ ] Outaouais
- [ ] Abitibi-Témiscamingue
- [ ] Côte-Nord
- [ ] Nord-du-Québec
- [ ] Gaspésie–Îles-de-la-Madeleine
- [ ] Chaudière-Appalaches
- [ ] Laval
- [ ] Lanaudière
- [ ] Laurentides
- [ ] Montérégie
- [ ] Centre-du-Québec

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

How much do you estimate the turnover of your company?

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Less than $1M
- ◯ 1M$ - 5M$
- ◯ 5M$ - 25M$
- ◯ 25M$ - 50M$
- ◯ 50M$ - 250M$
- ◯ Over $250M

What is the total number of employees in your company?

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ 1 - 5
- ◯ 6 - 10
- ◯ 11- 25
- ◯ 26 - 50
- ◯ 51 - 100
- ◯ 101 - 500
- ◯ 501 and more

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

29/02/2024, 12:42 LimeSurvey Cloud - Your online survey service - Survey on perceptions regarding the adoption of Integrated Project Delivery (IPD) in Quebec

What is your current role in the company?

Choose one of the following answers
Please choose **only one** of the following:

- Company management
- Innovation Manager
- Project Manager
- Construction manager
- Designer
- Sales manager
- Estimator
- Technician / modeller / draftsman
- Superintendent / Foreman
- Construction worker
- Other

IPD Awareness

Are you familiar with Integrated Project Delivery (IPD)?

*

Choose one of the following answers
Please choose **only one** of the following:

- Yes
- No

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

What is your level of knowledge regarding IPD? Please select from the options below:

Only answer this question if the following conditions are met:
Answer was 'Yes' at question ' [G03Q04]' (Are you familiar with Integrated Project Delivery (IPD)?
)

❗ Choose one of the following answers
Please choose **only one** of the following:

◯ No knowledge
◯ Basic
◯ Intermediate
◯ Advanced
◯ Expert

Do you have experience participating in an IPD project, either in a real-world setting or as part of an educational exercise?

Only answer this question if the following conditions are met:
Answer was 'Yes' at question ' [G03Q04]' (Are you familiar with Integrated Project Delivery (IPD)?
)

❗ Choose one of the following answers
Please choose **only one** of the following:

◯ Yes
◯ No

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

From your perspective, what are the three most significant obstacles to IPD implementation?

Only answer this question if the following conditions are met:
Answer was 'Yes' at question ' [G03Q04]' (Are you familiar with Integrated Project Delivery (IPD)?)

Please write your answer(s) here:

Challenge 01

Challenge 02

Challenge 03

From your perspective, what are the primary considerations for an organization in the construction sector looking to implement IPD?

Only answer this question if the following conditions are met:
Answer was 'Yes' at question ' [G03Q04]' (Are you familiar with Integrated Project Delivery (IPD)?)

Please write your answer(s) here:

Factor 01

Factor 02

Factor 03

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

« IPD (Integrated Project Delivery) is a relational contractual approach that emphasizes a high level of team integration, especially in fostering trust. It involves key participants—including the client, architect, engineers, and contractor—early in the project to ensure collaboration with aligned objectives for project success in terms of quality, cost, and schedule (Frantz et al., 2021). Unlike traditional delivery methods, where each stakeholder operates with their own interests in mind, IPD promotes a shared approach to risk and reward. This means no legal actions can be taken among the project team members. Instead, everyone commits upfront to jointly manage risks, with high-performing parties assisting and supporting those who face challenges. (Allison et al,2018)

Only answer this question if the following conditions are met:
Answer was 'No' at question ' [G03Q04]' (Are you familiar with Integrated Project Delivery (IPD)?
)

Based on the definition provided, are you familiar with the IPD contractual mode?

Only answer this question if the following conditions are met:
Answer was 'No' at question ' [G03Q04]' (Are you familiar with Integrated Project Delivery (IPD)?
)

Choose one of the following answers
Please choose **only one** of the following:

- Yes
- No

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

How would you rate the impact of the following characteristics of IPD on the success of the project:

Please choose the appropriate response for each item:

	Very negative	Negative	No impact	Positive	Very positive
A delivery method that hinges on the relationships among the project participants	◯	◯	◯	◯	◯
Selection of team members based on best value (qualitatively assessed rather than simply choosing the lowest bidder)	◯	◯	◯	◯	◯
The execution of a multi-party agreement, meaning a single contract is signed by multiple stakeholders, including the client, the architect, the contractor, etc.	◯	◯	◯	◯	◯
The waiver of legal action between the signatories to the contract.	◯	◯	◯	◯	◯
Complete financial transparency among team members, achieved through open book accounting	◯	◯	◯	◯	◯
Integration of team members into cross-disciplinary work groups	◯	◯	◯	◯	◯
Collective and collaborative decision-making, instead of decisions made by a single stakeholder independently	◯	◯	◯	◯	◯
Co-location of the team in a project office	◯	◯	◯	◯	◯
Early involvement of subcontractors and suppliers	◯	◯	◯	◯	◯
The establishment of a 'Big Room' – a collaborative meeting space where project meetings are held	◯	◯	◯	◯	◯
Aligning project participants with the project's values and objectives	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

	Very negative	Negative	No impact	Positive	Very positive
Visual display and planning, especially through the use of the Last Planner scheduling system, which involves displaying all tasks and their relationships to the project on a board visible to everyone	◯	◯	◯	◯	◯
Continuous training within the project	◯	◯	◯	◯	◯
Mutual trust between project team members	◯	◯	◯	◯	◯
Identification of common values for all members of the project team.	◯	◯	◯	◯	◯
Identifying common goals for all members of the project team.	◯	◯	◯	◯	◯
Incentives (financial or otherwise) tied to the overall performance of the project, particularly in achieving shared objectives	◯	◯	◯	◯	◯
Identifying and executing the project at a target cost (or value), determined collaboratively for the benefit of all team members	◯	◯	◯	◯	◯
Shared risk among project participants	◯	◯	◯	◯	◯
Shared rewards among project participants	◯	◯	◯	◯	◯
The implementation of new technologies including BIM	◯	◯	◯	◯	◯
Utilizing Lean tools such as A3 sheets, 5S, Choosing By Advantages (CBA), "pull planning", and others.	◯	◯	◯	◯	◯
Continuous performance measurement	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

How comfortable are you with implementing each of the following elements of IPD in a project:

Please choose the appropriate response for each item:

	Very uncomfortable	Uncomfortable	Neutral	Comfortable	Very comfortable
A delivery method that emphasizes the relationships among project participants instead of the transactions between parties to a contract	◯	◯	◯	◯	◯
Selection of team members based on best value (qualitatively assessed rather than simply choosing the lowest bidder)	◯	◯	◯	◯	◯
The execution of a multi-party agreement, meaning a single contract is signed by multiple stakeholders, including the client, the architect, the contractor, etc.	◯	◯	◯	◯	◯
The waiver of legal action between the signatories to the contract.	◯	◯	◯	◯	◯
Complete financial transparency among team members, achieved through open book accounting	◯	◯	◯	◯	◯
Integration of team members into cross-disciplinary work groups	◯	◯	◯	◯	◯
Collective and collaborative decision-making, instead of decisions made by a single stakeholder independently	◯	◯	◯	◯	◯
Co-location of the team in a project office	◯	◯	◯	◯	◯
Early involvement of subcontractors and suppliers	◯	◯	◯	◯	◯
The establishment of a 'Big Room' – a collaborative meeting space where project meetings are held	◯	◯	◯	◯	◯
Aligning project participants with the project's values and objectives	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

	Very uncomfortable	Uncomfortable	Neutral	Comfortable	Very comfortable
Visual display and planning, especially through the use of the Last Planner scheduling system, which involves displaying all tasks and their relationships to the project on a board visible to everyone	◯	◯	◯	◯	◯
Continuous training within the project	◯	◯	◯	◯	◯
Mutual trust between project team members	◯	◯	◯	◯	◯
Identification of common values for all members of the project team.	◯	◯	◯	◯	◯
Identifying common goals for all members of the project team.	◯	◯	◯	◯	◯
Incentives (financial or otherwise) tied to the overall performance of the project, particularly in achieving shared objectives	◯	◯	◯	◯	◯
Identifying and executing the project at a target cost (or value), determined collaboratively for the benefit of all team members	◯	◯	◯	◯	◯
Shared risk among project participants	◯	◯	◯	◯	◯
Shared rewards among project participants	◯	◯	◯	◯	◯
The implementation of new technologies including BIM	◯	◯	◯	◯	◯
Utilizing Lean tools such as A3 sheets, 5S, Choosing By Advantages (CBA), "pull planning", and others.	◯	◯	◯	◯	◯
Continuous performance measurement	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

From your perspective, what is or would be the impact of implementing IPD on the following performance indicators?

Please choose the appropriate response for each item:

	Very negative	Negative	Neutral	Positive	Very positive
The constructability of the project	◯	◯	◯	◯	◯
Early detection of conflicts and issues	◯	◯	◯	◯	◯
The total duration of the project	◯	◯	◯	◯	◯
Schedule reliability	◯	◯	◯	◯	◯
Cost reliability	◯	◯	◯	◯	◯
Overall project performance	◯	◯	◯	◯	◯
Productivity of the project team members	◯	◯	◯	◯	◯
The overall quality of the project's systems	◯	◯	◯	◯	◯
The waste generated during the construction phase	◯	◯	◯	◯	◯
The relationship between the owner and the contractor	◯	◯	◯	◯	◯
Owner Satisfaction	◯	◯	◯	◯	◯
Team member satisfaction	◯	◯	◯	◯	◯
Transparency in taxation	◯	◯	◯	◯	◯
Project ownership by team members	◯	◯	◯	◯	◯
Owners' control over risks	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

	Very negative	Negative	Neutral	Positive	Very positive
The number of changes throughout the project	◯	◯	◯	◯	◯
The count of issues or deficiencies	◯	◯	◯	◯	◯
The quantity of Requests for Information (RFI)	◯	◯	◯	◯	◯
Value for money	◯	◯	◯	◯	◯
Time taken for decision-making	◯	◯	◯	◯	◯
Time taken to process inquiries	◯	◯	◯	◯	◯
Change order processing time	◯	◯	◯	◯	◯
Work environment and conditions for employees	◯	◯	◯	◯	◯
Cost to complete the project	◯	◯	◯	◯	◯
Total project costs	◯	◯	◯	◯	◯
Design changes	◯	◯	◯	◯	◯
Relationships between team members	◯	◯	◯	◯	◯
Overall project risk exposures	◯	◯	◯	◯	◯
Integration and collaborative among project team members	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

How would you rank the impact of the following challenges on the implementation of IPD?

Please choose the appropriate response for each item:

	No impact	Low impact	Medium impact	High impact	Very high impact
Lack of client demand	◯	◯	◯	◯	◯
High initial costs for implementation	◯	◯	◯	◯	◯
Lack of knowledge about IPD	◯	◯	◯	◯	◯
Prevalent culture and behavior within the industry	◯	◯	◯	◯	◯
Legal and contractual difficulties	◯	◯	◯	◯	◯
Lack of familiarity with Lean and its principles	◯	◯	◯	◯	◯
Complexity of IPD implementation	◯	◯	◯	◯	◯
Lack of external support	◯	◯	◯	◯	◯
Lack of confidence in IPD	◯	◯	◯	◯	◯
Lack of interest and incentives by industry stakeholders	◯	◯	◯	◯	◯
Absence of fair sharing of profits and losses	◯	◯	◯	◯	◯
Selection based on the lowest bid	◯	◯	◯	◯	◯
Lack of knowledge of IPD benefits	◯	◯	◯	◯	◯
Uncertainty regarding return on investment	◯	◯	◯	◯	◯

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

29/02/2024, 12:42 LimeSurvey Cloud - Your online survey service - Survey on perceptions regarding the adoption of Integrated Project Delivery (IPD) in Quebec

	No impact	Low impact	Medium impact	High impact	Very high impact
Reluctance to share profits	◯	◯	◯	◯	◯

Thank you for your participation

Submit your survey.
Thank you for completing this survey.

Figure A E.1 Survey -IPD Awareness, Perceptions, And Challenges (continued)

APPENDIX F

INTERVIEW– IPD EFFECT ON ORGANIZATIONAL PRACTICES – ANNEX III

Interview- IPD Ripple effect

Section 1: Background Information

The questions in this section depend on whether the interviewee participated in the survey and provided this information.

1. **Could you briefly describe your role in your organization?**
2. **What type of organization do you work for, and in which construction sector is it primarily involved?**
3. **Have you participated in any IPD projects? If yes, could you describe the most recent IPD project you were involved in?**

Section 2: Organizational Perspectives

Organizational Culture:

4. **Can you speak to how IPD has transformed the organizational culture in your company?**
   If they need more clarification (Are there notable changes in attitudes, beliefs, or behaviors that you've observed?)

Management of Organization:

5. **Can you speak to how IPD has influenced the way your organization is managed?**
   If they need more clarification (particularly in terms of integrating project-related roles and any structural or role changes?)

Section 3: Process and Practices

Communication and Information Sharing:

6. **Can you speak to the flow of information between the IPD project team and your organization during the project?**
   If they need more clarification (Were there any changes in communication channels or patterns?)

Figure A F.1 Interview – IPD Effect on Organization Practices

Decision-Making:

7. **Can you speak to any changes in your organization's decision-making processes as a result of adopting IPD?**

   If they need more clarification (How the decision-making structure of IPD projects align with your organization's own practices?)

Procurement and Supply Chain:

8. **Can you speak to any changes that have occurred in the procurement approaches in your organization as a result of the approaches used in IPD projects?**

   If they need more clarification (How do these procurement approaches align with your organization's own practices?)

Resource Allocation:

9. **Can you speak to any changes in resource allocation strategies within your organization as a result of IPD projects?**

   If they need more clarification (How do these strategies align with your organization's existing resource management practices?)

Risk Management:

10. **Can you speak to any changes in risk management practices within your organization that have been influenced by IPD projects?**

    If they need more clarification (How do these practices align with your organization's overall risk management strategies?)

Performance Evaluation:

11. **Can you speak to any changes in how your organization measures success due to IPD projects?**

Figure A F.1 Interview – IPD Effect on Organization Practices (continued)

If they need more clarification (Any new metrics or indicators introduced as a result of IPD projects?)

Section 4: Learning and Knowledge Transfer

12. **Can you speak to how IPD has influenced knowledge transfer within your organization?**

    If they need more clarification (How is knowledge from IPD projects disseminated, and does it contribute to organizational learning and the development of best practices?)

Additional Feedback:

13. **Based on your experience, what improvements or changes would you suggest to help your organization make the most of its future IPD projects?**
14. **Would you like to add anything that we haven't covered regarding IPD's impact on your organization's practices?**

Figure A F.1 Interview – IPD Effect on Organization Practices (continued)

APPENDIX G

SURVEY– IPD EFFECT ON ORGANIZATIONAL PRACTICES – ANNEX III

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Survey- IPD Ripple Effect

Section 1: IPD Participation and Experience

1. Has your organization ever participated in an IPD project (e.g. a project with a multiparty agreement, liability waiver and joint risk and reward structure, among other things)?
   - Yes
   - No
2. How familiar are you with the concept of Integrated Project Delivery (IPD)?
   - **Not at all familiar** (I never heard of it, or I do not know much about its principles and how it works)
   - **Slightly familiar** (I have a certain knowledge about it but never participated in an IPD project)
   - **Moderately familiar** (I have completed, or I am currently going through my first IPD project)
   - **Very familiar** (I have completed 2-3 IPD projects)
   - **Extremely familiar** (I have completed more than 3 IPD projects)

Section 2: Organizational Perspectives:

Based on your latest IPD project, please answer the following questions:

Organizational Culture:

3. Are there any changes to attitudes, beliefs, or behaviors within the organization as a result of implementing the IPD project approach?
   - Yes, there are **positive** changes in attitudes, beliefs, or behaviors. Please specify how: ____________
   - Yes, there are **negative** changes in attitudes, beliefs, or behaviors. Please specify how: ____________
   - No, attitudes, beliefs, or behaviors remain the same.
   - Not applicable/ Do not know

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Research on the 'Ripple Effect' of IPD

Figure A G.1 Survey – IPD Effect on Organization Practices

Management of the organization:

4. How are project-related roles integrated into the existing organizational structure?
   - **No integration**- IPD Project-related roles are not integrated into the existing organizational structure, leading to a complete lack of coordination and collaboration.
   - **Very little integration**- IPD Project-related roles are minimally integrated into the existing organizational structure, resulting in significant coordination and collaboration issues.
   - **Limited integration**- IPD Project-related roles have limited integration into the existing organizational structure, leading to challenges in coordination and communication.
   - **Moderate integration**- IPD Project-related roles are moderately integrated into the existing organizational structure, with some room for improvement in terms of coordination and alignment.
   - **Significant integration**- IPD Project-related roles are seamlessly integrated into the existing organizational structure, facilitating clear coordination and communication.
5. Are there any changes in the organization's structure or roles due to the IPD project approach?
   - Yes, there are changes in the organization's structure or roles as a result of the IPD project approach. Please specify the nature and impact of these changes in the comment box: ____________
   - No, there are no changes in the organization's structure or roles as a result of the IPD project approach.
   - Not applicable/Do not know.

Section 3: Process and Practices:

Based on your latest IPD project, please answer the following questions:

Communication and Information sharing:

6. What best describes how the information flow between the IPD project team and your organization during the project?

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

Research on the 'Ripple Effect' of IPD

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- **Very Ineffective**- The information flow is very ineffective, hindering collaboration and causing significant communication gaps.
- **Ineffective** - The information flow is generally ineffective, driving some difficulties and gaps in communication and collaboration.
- **Somewhat effective** - The effectiveness of information flow is Somewhat effective, with room for improvement.
- **Effective** - The information flow is generally effective, facilitating adequate communication and collaboration between the IPD project team and their organization.
- **Very effective** - The information flow is highly effective, enabling seamless communication and collaboration between the IPD project team and their organization.

7. Are there any changes in communication channels or patterns between the project team and the organization due to adopting the IPD approach?
    - Yes, there are changes in communication patterns and channels. Please specify the nature and impact of these changes in the comment box: ____________
    - No, communication patterns and channels remain the same.
    - Not applicable/ Do not know

Decision-Making:

8. How does the IPD project decision structure align with the organization's decision-making structure?
    - **Not aligned at all** -IPD project decision structure contradicts the organization's decision-making structure, and decisions at the project level are not integrated into the organization's decision-making framework.
    - **Limited alignment** -IPD project decision structure is barely aligned with the organization's decision-making structure, causing difficulties in focusing on the organization's best interest.
    - **Somewhat aligned** -IPD project decision structure somewhat aligns with the organization's decision-making structure.

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Research on the 'Ripple Effect' of IPD

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

Research on the 'Ripple Effect' of IPD

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- **Moderate alignment** -IPD project decision structure has substantial alignment with the organization's decision-making structure, driving the outcomes to be well aligned with the organization's best interest.
- **Significant alignment** -IPD project decision structure aligns closely with the organization's decision-making structure, and decisions at the project level are effectively communicated and integrated into the organization's decision-making framework.

9. Are there any changes to the organization decision-making processes as a result of the IPD project approach?
   - Yes, there are changes in the organization's decision-making processes. Please specify the nature and impact of these changes in the comment box: ____________
   - No, organization's decision-making processes remain the same.
   - Not applicable/ Do not know

Procurement and Supply Chain:

10. How does the procurement approach within IPD project align with the organization's procurement and supply chain strategies?
    - **Not aligned** - The IPD project doesn't align well with the organization's strategies, leading to challenges.
    - **Limited alignment** - The IPD project somewhat misaligns with the organization's procurement and supply chain strategies, causing discrepancies.
    - **Somewhat align** - The IPD project has some alignment with the organization's strategies but could be better integrated.
    - **Moderate alignment** - The IPD project aligns well with the organization's strategies, ensuring consistent practices.
    - **Significant alignment** - The IPD project aligns strongly with the organization's strategies, promoting seamless operations.
11. Are there any changes in the organization's procurement or supply chain due to the IPD project?
    - Yes, there are changes due to the IPD approach. Please specify the nature and impact of these changes in the comment box: ____________
    - No, practices remain the same.

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

- Not applicable/ Do not know

Resource Allocation:

12. How does the IPD project approach align with the organization's resource allocation strategy?
    - **Not aligned at all** - IPD project approach contradicts the organization's resource allocation strategy, requiring major adjustments.
    - **Limited alignment** - IPD project approach is barely aligned with the organization's resource allocation strategy, leading to some challenges in effective allocation.
    - **Somewhat aligned** - IPD project approach somewhat aligns with the organization's resource allocation strategy, having neither significant positive nor negative impacts.
    - **Moderate alignment** - IPD project approach has substantial alignment with the organization's resource allocation strategy, enabling seamless resource allocation.
    - **Significant alignment** - IPD project approach aligns closely with the organization's resource allocation strategy, ensuring efficient and effective allocations without needing adjustments.
13. Are there any changes to resource management practices or policies as a result of the IPD project approach?
    - Yes, there are changes in resource management practices. Please specify the nature and impact of these changes in the comment box: ____________
    - No, resource management practices remain the same.
    - Not applicable/ Do not know

Learning and Knowledge Transfer:

14. How does knowledge gained at the IPD project level get transferred and disseminated throughout the organization?
    - **No knowledge transfer**- There is no systematic knowledge transfer from the project level to the broader organization.
    - **Very Little knowledge transfer**- Knowledge gained at the project level is inadequately transferred and disseminated throughout the organization.
    - **Limited knowledge transfer**- Knowledge gained at the project level has limited transfer and dissemination throughout the organization.

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

Research on the 'Ripple Effect' of IPD

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- **Moderate knowledge transfer**- Knowledge gained at the project level is moderately transferred and disseminated throughout the organization, with some room for improvement in terms of accessibility and reach.
- **Effective knowledge transfer**- Knowledge gained at the project level is effectively transferred and disseminated throughout the organization through established channels and practices.

15. Does the IPD project approach contribute to organizational learning, innovation, and the development of best practices?
    - Yes, the IPD project approach contributes to organizational learning and the development of best practices. Please specify how it contributes in the comment box: ____________
    - No, the IPD project approach does not contribute to organizational learning and the development of best practices.
    - Not applicable/Do not know.

Risk Management:

16. How does the risk management approach within the IPD project align with the organization's overall risk management?
    - **Not aligned at all** - The risk management approach within the IPD project significantly misaligns with the organization's overall risk management, resulting in challenges and inconsistencies.
    - **Limited alignment**- The risk management approach within the IPD project moderately misaligns with the organization's overall risk management, causing some discrepancies.
    - **Somewhat align**- The risk management approach within the IPD project partially aligns with the organization's overall risk management, with room for further integration and coordination.
    - **Moderate alignment** - The risk management approach within the IPD project substantially aligns with the organization's overall risk management, facilitating consistent in risk mitigation.
    - **Significant alignment** -The risk management approach within the IPD project strongly aligns with the organization's overall risk management, ensuring seamless integration.

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Research on the 'Ripple Effect' of IPD

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

17. Are there any changes to the organization's risk management practices or procedures as a result of the IPD project approach?

    - Yes, the IPD project approach has led to changes in the organization's risk management practices or procedures. Please specify the nature and impact of these changes in the comment box: ____________
    - No, the organization's risk management practices or procedures remain unchanged.
    - Not applicable/Do not know.

Performance Measurement and Evaluation:

18. How would you describe the impact of IPD projects on your organization's overall performance and outcomes?

    - **Significant negative impact**- IPD projects have a significant negative impact on the organization's overall performance, resulting in declining outcomes.
    - **Moderate negative impact**- IPD projects have a moderate negative impact on the organization's overall performance, resulting in some challenges in meeting the usual outcomes.
    - **No impact**- IPD projects do not significantly impact the organization's overall performance and outcomes.
    - **Moderate positive impact**- IPD projects have a moderately positive impact on the organization's overall performance, contributing to noticeable improvements in outcomes.
    - **Significant positive impact**- IPD projects have a significant positive impact on the organization's overall performance, resulting in significantly improved outcomes.

19. Has the IPD project approach resulted in any changes in performance metrics, or how is project success determined at the organizational level?

    - Yes, the IPD project approach has resulted in changes in performance metrics or how project success is determined. Please describe the nature and significance of these changes: ____________
    - No, performance metrics or project success criteria remain unchanged.
    - Not applicable/Do not Know.

Research on the 'Ripple Effect' of IPD

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

Research on the 'Ripple Effect' of IPD

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Section 4: Lean Tools and Techniques:

Based on your latest IPD project, please answer the following questions:

Lean Tools and Techniques:

20. Which of the following tools were used in your project? and which of those used in your project were then adopted and implemented in your organization? Check all that apply
    - Last Planner System. Was it adopted and implemented in your organization _____
    - Plus/Deltas. Was it adopted and implemented in your organization __________
    - A3 & 5Why. Was it adopted and implemented in your organization __________
    - Dashboards. Was it adopted and implemented in your organization __________
    - Visual Documentation. Was it adopted and implemented in your organization __________
    - Establishing Conditions of Satisfaction (CoS). Was it adopted and implemented in your organization __________
    - Live Estimating/Forecasting. Was it adopted and implemented in your organization __________
    - Decision Matrix. Was it adopted and implemented in your organization __________
    - Choosing By Advantages. Was it adopted and implemented in your organization __________
    - BIM/VDC. Was it adopted and implemented in your organization __________
    - Risk Register. Was it adopted and implemented in your organization __________
    - Customized tools (name it). Was it adopted and implemented in your organization __________

21. What best describes the effect that the Lean tools and techniques implemented in the IPD project have on the everyday operations and procedures of the organization?
    - **Significant negative impact**- The lean tools and techniques implemented in the IPD project significantly undermine the organization's operations and processes.
    - **Moderate negative impact**- The lean tools and techniques implemented in the IPD project moderately affect the organization's operations and processes.
    - **No impact**- The lean tools and techniques implemented in the IPD project have no significant impact on the organization's operations and processes.

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Research on the 'Ripple Effect' of IPD

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

- **Moderate positive impact**- The lean tools and techniques implemented in the IPD project moderately enhance the organization's operations and processes, contributing to improved efficiency and productivity.
- **Significant positive impact**- The lean tools and techniques implemented in the IPD project have a significant positive impact on the organization's operations and processes, resulting in significantly improved efficiency, productivity, and reduced waste.

Section 5: Outlook and feedback:

Future Considerations:

22. Is your organization planning to continue participating in IPD projects in the future?

- Yes, my organization is planning to continue participating in IPD projects in the future. If this answer was chosen then another question will appear: What is the most important factor/s that would influence your organization's decision to participate in more IPD projects? ____________
- No, my organization is not planning to continue participating in IPD projects in the future. If this answer was chosen, another question will appear: What is the most important factor/s that would influence your organization's decision to not participate in more IPD projects? ____________
- Do not Know

Section 6: Demographic Information

Demographic Information:

23. What is the type of organization you are employed by? Please choose the most relevant option:

- Owner/Client
- General Contractor
- Subcontractor/Trade Contractor
- Engineering/Design Firm
- Facilitating/Consulting Firm
- Other (Please specify)

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

24. What is your role in the organization? ___________

25. In which construction sector does your company work? Please choose all that apply:

- Infrastructure
- Residential
- Institutional
- Commercial
- Industrial

26. How would you categorize the operational scale of your organization? Please select only one of the following:

- Regional Presence: Has operations in multiple cities or throughout a region/province/state. In which country and province/state ----
- National Presence: Has operations throughout the country. In which country -------
- Multinational Presence: Operates in more than one country. In which countries -----

Figure A G.1 Survey – IPD Effect on Organization Practices (continued)

APPENDIX H

IPD MATURITY ASSESSMENT TOOL (IPD-MAT) – CHAPTER 3

Competency Set	#	Competency	Five-point Likert scale								Consolidated Score	Maturity Level
			Q #	Q weight	Question							
Competency Set 1: Understanding and Facilitation	1.1	General understanding			IPD Principles and Processes:							
			Q1	25%	Well Understood?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q2	25%	The relevance of IPD principles and processes to our project's success is widely recognized?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q3	25%	IPD principles and processes are thoroughly integrated into our project's execution?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q4	25%	The project adapts and enhances IPD practices based on specific project needs and outcomes?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
	1.2	Facilitation			Through the facilitation process:							
			Q5	25%	Facilitation process includes a thorough assessment to identify gaps in the team's understanding of IPD practices?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q6	25%	New team members are consistently trained on IPD tools and techniques as part of their on-boarding?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q7	25%	Facilitation processes effectively enhance understanding and application of IPD principles?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q8	25%	Facilitation activities contribute to establishing a favorable culture?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
	1.3	Team Building			In the team-building process:							
			Q9	16.67%	Efforts to establish a unified and cohesive team culture are effectively integrated into project activities as a key driver for success?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q10	16.67%	Steps to establish a flat hierarchy within the project are effectively implemented?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q11	16.67%	Steps to encourage open communication are taken?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q12	16.67%	The project environment supports a blame-free culture?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q13	16.67%	The project environment encourages participation?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q14	16.67%	The team-building process continuously incorporates new methods and techniques to enhance collaboration?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
Competency Set 2: Goal Setting and Contract Development	2.1	Developing Project Goals (Validation Process)			Project Validation Process:							
			Q15	14.29%	Is structured?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q16	14.29%	Is collaborative?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q17	14.29%	Conducted with active participation of all IPD project members?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q18	14.29%	Enhances a favorable team culture?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q19	14.29%	Resulted in clearly defined project goals?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q20	14.29%	The validation report is clear and comprehensive, effectively contributing essential information for contract development?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q21	14.29%	The validation process sought to introduce new methods, techniques, and solutions to meet the project objectives?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
	2.2	Defining project values			The projects core values are:							
			Q22	20%	Well defined?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q23	20%	Clearly communicated?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q24	20%	Regularly referenced to guide the decision-making process?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q25	20%	Continuously revisited?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q26	20%	Actively strengthened through new methods?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
	2.3	Contract Formulation			Contract Formulation:							
			Q27	25%	Is conducted collaboratively with the active participation of all IPD members?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q28	25%	Integrate all IPD principles and features?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q29	25%	Utilized different facilitation means, such as workshops and expert consultations?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		
			Q30	25%	Is optimized to better suit project conditions and enhance collaboration?	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree		

Figure A H.1 IPD Maturity Assessment Tool

Competency Set	#	Competency	Five-point Likert scale				
			Q #	Q weight	Question	Consolidated Score	Maturity Level
Competency Set 3: Project Governance	3.1	Defining Roles and Responsibilities	The Process of Defining Roles and Responsibilities				
			Q31	16.67%	Results in clearly defined roles and responsibilities? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q32	16.67%	Minimizes overlaps and conflicts? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q33	16.67%	Includes all parties in discussions on roles and responsibilities? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q34	16.67%	Communicates roles and responsibilities clearly? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q35	16.67%	Fosters a unified understanding of roles and accountability structures? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q36	16.67%	Adapts roles flexibly to meet project needs? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	3.2	Decision-Making Process	Decision-Making Process:				
			Q37	14.29%	Includes all relevant IPD members in the process? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q38	14.29%	Conducts decision-making transparently? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q39	14.29%	Is guided by project goals? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q40	14.29%	Utilizes decision matrices and other tools to evaluate alternatives? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q41	14.29%	Leads to informed decisions? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q42	14.29%	Documents decisions thoroughly, providing clear context and rationale for each decision? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q43	14.29%	Demonstrates adaptability and agility to meet evolving project needs? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	3.3	Management Structure	Management Structure:				
			Q44	20%	Is clearly defined, with distinct roles and responsibilities among different levels (SMT, PMT, PIT)? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q45	20%	Effectively coordinates activities across different management levels (SMT, PMT, PIT)? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q46	20%	Effectively coordinates decisions across different management levels (SMT, PMT, PIT)? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q47	20%	Demonstrates adaptability by adjusting management practices to meet the evolving needs of the project? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q48	20%	Actively seeking to integrate new and effective management strategies to enhancce collaboration and efficiency across SMT, PMT, and PIT? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	3.4	Owner involvement	Owner Involvement:				
			Q49	14.29%	Actively involved in project decision-making? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q50	14.29%	Actively involved in day-to-day project operations? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q51	14.29%	Plays a central role in project governance? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q52	14.29%	Fully embracing and advancing the IPD model? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q53	14.29%	Actively contributes to fostering a collaborative environment? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q54	14.29%	Actively contributes to fostering a favorable team culture? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q55	14.29%	Serves as a role model through leadership and commitment? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		

Figure A H.1 IPD Maturity Assessment Tool (continued)

Competency Set	#	Competency	Q #	Q weight	Question	Five-point Likert scale	Consolidated Score	Maturity Level
Competency Set 4: Operational Excellence	4.1	Operational Culture			Operational Culture:			
			Q56	20%	Promotes a shift from traditional practices to Lean practices?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q57	20%	Encourages and supports a collaborative work environment?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q58	20%	Adopts a no-blame culture?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q59	20%	Implements and regularly assesses practices that enhance Lean culture?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q60	20%	Actively encourages the adoption of new methods and techniques to enhance the collaborative culture?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	4.2	Operational Principles			Operational Principles:			
			Q61	16.67%	Driven by principles that emphasize streamlining workflows?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q62	16.67%	Emphasize reducing waste?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q63	16.67%	Emphasize maximizing value?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q64	16.67%	Emphasize continuous improvement?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q65	16.67%	The Integration between Lean and IPD principles into project operations is evident and effective?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q66	16.67%	The application of operational principles actively contributes to the development of advanced project management practices?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	4.3	Tools			In regard to Tools utilization:			
			Q67	16.67%	BIM is used effectively for both basic visualization and coordination tasks, including clash detection?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q68	16.67%	BIM enhances project collaboration and communication, serving as a central element in the project management strategy?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q69	16.67%	BIM model serve as a reliable and comprehansive source of project information?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q70	16.67%	BIM improves the quality of project information by constantly enabling new capabilities and efficiency?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q71	16.67%	Lean tools like pull planning, plus/delta, target value design, and more are used frequently to streamline workflows and maximize value?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q72	16.67%	Lean tools and techniques are core to the project's operational practices?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	4.4	Dynamics			Dynamics of Multidisciplinary Teams:			
			Q73	20%	Teams inclusively structured to integrate a broad range of disciplines effectively?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q74	20%	Team formations flexible, allowing for adaptation to changing project needs?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q75	20%	Responsibilities within teams clearly defined?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q76	20%	Teams have full authority to make decisions and manage their tasks completely?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q77	20%	Team dynamics facilitate collaboration across disciplines?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	4.5	Engagement			In regard to Engagement stratigies:			
			Q78	25%	Communication within the project is confined to formal methods like emails or documents?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q79	25%	The project encourges direct and informal engagement through diverse communication channels including digital platforms and big-room meetings?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q80	25%	Communication and engagement strategies are inclusive, keeping all team members, including on-site personnel, well-informed and aligned with project goals?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q81	25%	The project actively seeks new and advance techniques in engagement strategies to enhance communication and collaboration?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	4.6	Work Environment			In regard to Work Environment:			
			Q82	16.67%	Big Room meetings are held frequently (physical or virtual)?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q83	16.67%	The setup of the Big Room is designed to promote inclusivity, featuring arrangements such as equal seating and no-title zones?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q84	16.67%	Big Room sessions effectively foster engagement among team members?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q85	16.67%	Big Room sessions enhance team unity?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q86	16.67%	Big Room sessions improve collaboration among all team members?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q87	16.67%	Big Room settings actively incorporate advanced tools and techniques?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		

Figure A H.1 IPD Maturity Assessment Tool (continued)

Competency Set	#	Competency	Q #	Q weight	Question (Five-point Likert scale)	Consolidated Score	Maturity Level
Competency Set 5: Management and Oversight	5.1	Information Management			In Regard to Information Management:		
			Q88	25%	Information within the project is structured and easily accessible? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q89	25%	Information is shared through digitaal means? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q90	25%	Information systems provide real-time access to data for all project members? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q91	25%	Advanced technologies such as AI, digital twins, and VR are employed to enhance data utilization and support decision-making processes? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	5.2	Financial Practices			In Regard to Financial Practices:		
			Q92	16.67%	Efforts to integrate team members in financial discussions are effectively implemented, fostering a culture of shared financial responsibility? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q93	16.67%	Financial activities are managed transparently, promoting open-book accounting and clarity? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q94	16.67%	The project represents a mature culture of shared financial responsibility and solid individual accountability? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q95	16.67%	Incentive mechanisms are actively employed? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q96	16.67%	Incentive mechanisms are refined to sustain collaboration and enhance team performance? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q97	16.67%	Project employs advanced strategies and tools to support financial decision-making? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	5.3	Risk Practices			In Regard to Risk practices:		
			Q98	20%	Risk management practices include all IPD members? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q99	20%	Risk management practices are conducted frequently? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q100	20%	Collaborative tools like risk registers are regularly used to identify and assess risks? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q101	20%	Collective ownership of risk management processes is well-established? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q102	20%	The project continuously seeks and applies new methods and strategies to enhance the effectiveness of risk management practices? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
	5.4	Performance Monitoring			In regard to Performance Monitoring:		
			Q103	20%	Project dashboards visualize broad range of performance metrics such as budget, schedule, safety, culture, and more? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q104	20%	Data collection across all project disciplines is standardized, providing a holistic view of the project status? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q105	20%	Performance metrics are adapted to the specific needs of the project? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q106	20%	Performance metrics facilitate decision-making? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q107	20%	Advanced technologies and tools are employed to enable real-time data integration into dashboards? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
Competency Set 6: IPD Continuous Learning	6.1	Continuous Learning and Improvement			In regard to Continuous Learning and Improvement:		
			Q108	16.67%	Lessons learned are systematically captured using structured processes and tools? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q109	16.67%	Feedback on IPD practices is regularly gathered and analyzed? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q110	16.67%	Stakeholder feedback is regularly gathered and analyzed? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q111	16.67%	Client satisfaction is regularly assessed and addressed? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q112	16.67%	Insights from lessons learned and feedback are integrated into project planning and execution to enhance effectiveness? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		
			Q113	16.67%	The project continuously seeks and applies new methods and strategies for capturing and utilizing feedback? 1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree		

Figure A H.1 IPD Maturity Assessment Tool (continued)

APPENDIX I

MATURITY ASSESSMENT REPORT – CHAPTER 3

IPD Maturity Assessment Report

[redacted]

Date: September 04, 2024

Executive Summary:
The IPD Maturity Report for the [redacted] evaluates the implementation maturity of Integrated Project Delivery (IPD) across six key competency sets: Understanding and Facilitation, Goal Setting and Contract Development, Project Governance, Operational Excellence, Management and Oversight, and Continuous Learning. Maturity levels are categorized into five stages based on total scores achieved: Initial (1.0 - 1.9), Defined (2.0 - 2.9), Managed (3.0 - 3.9), Proficient (4.0 - 4.5), and Advanced (4.6 - 5.0). The findings indicate a varied maturity landscape where most competency sets range from Managed to Proficient. Notably, the Work Environment has excelled, reaching an Advanced level and showcasing exemplary integration and utilization of collaborative spaces. Conversely, the Contract Formulation is still at the Defined stage, highlighting significant room for improvement.

Understanding and Facilitation: The evaluation of this competency demonstrates a proficient understanding and integration of IPD principles while achieving a managed level of facilitation and team-building competencies. The team effectively comprehends and applies IPD concepts, although there are opportunities to enhance facilitation methods and ongoing team-building strategies.

Goal Setting and Contract Development: This competency set reflects a balanced approach to defining project goals and values, with "Managed" and "Proficient" levels noted in these areas. However, it identifies the need for improvement in the contract formulation process, where facilitation means, and optimization strategies require enhancement to better suit project conditions.

Project Governance: This competency assesses the effectiveness of governance mechanisms. The evaluation reveals "Managed" to "Proficient" maturity levels, indicating robust governance structures that adequately support the project's goals. However, it highlights areas for improvement in transparency in decision-making processes, as well as stakeholder engagement in the roles and responsibilities discussions.

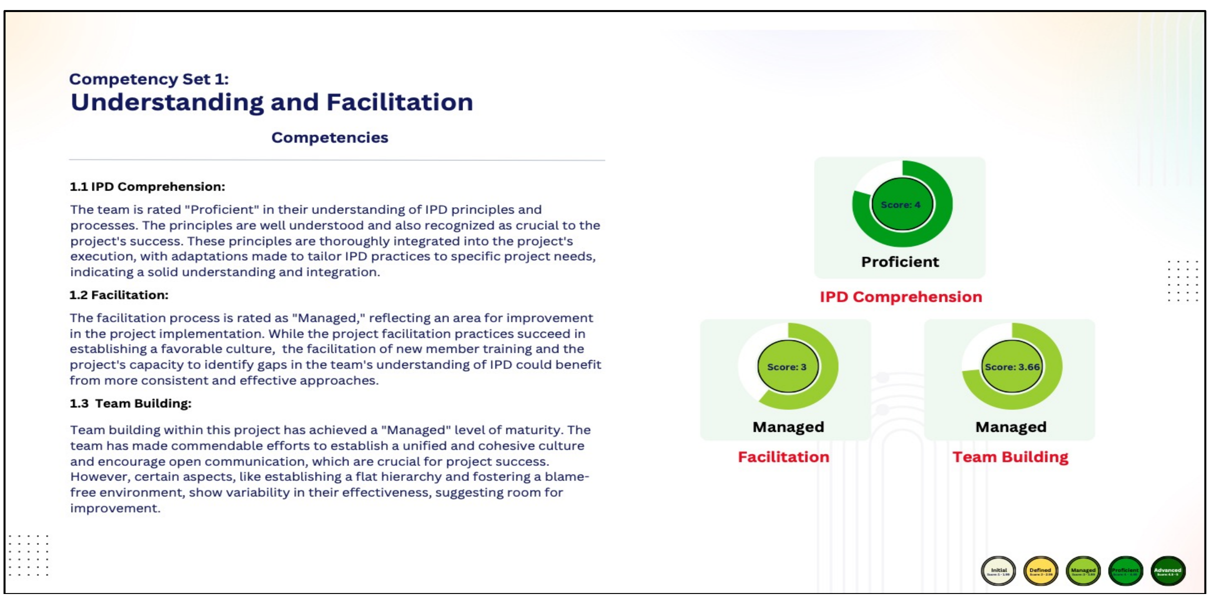
Operational Excellence: This competency evaluates the project's operational practices, highlighting a range of "Managed" to "Proficient" levels. The assessment underscores robust tool utilization and effective team dynamics, with significant advancements in the work environment. However, it identifies areas for growth in fully integrating Lean and IPD principles within operational strategies and broadening engagement approaches to foster more inclusive communication.

Management and Oversight: This competency evaluates the project's management and oversight mechanisms, predominantly rated as "Managed" with "Proficient" performance monitoring. The project shows strong information management and financial practices. However, areas such as advanced technology usage in information management and further refining financial incentive mechanisms need enhancement. Risk management practices, while regular and collaborative, could improve through broader inclusion and better tool usage. Performance metrics are effectively visualized and adapted, supporting robust decision-making.

Continuous Learning: Continuous Learning and Improvement: This competency evaluates how effectively the project captures and leverages learning to refine and advance its IPD practices. Rated as "Managed," the competency indicates structured yet moderate integration of continuous learning mechanisms, pointing towards areas for improvement.

[redacted]

Prepared by: Ahmad Arar, Erik Poirier, Sheryl Staub-French



Competency Set 1:

Understanding and Facilitation

Competencies

1.1 IPD Comprehension:

The team is rated "Proficient" in their understanding of IPD principles and processes. The principles are well understood and also recognized as crucial to the project's success. These principles are thoroughly integrated into the project's execution, with adaptations made to tailor IPD practices to specific project needs, indicating a solid understanding and integration.

1.2 Facilitation:

The facilitation process is rated as "Managed," reflecting an area for improvement in the project implementation. While the project facilitation practices succeed in establishing a favorable culture, the facilitation of new member training and the project's capacity to identify gaps in the team's understanding of IPD could benefit from more consistent and effective approaches.

1.3 Team Building:

Team building within this project has achieved a "Managed" level of maturity. The team has made commendable efforts to establish a unified and cohesive culture and encourage open communication, which are crucial for project success. However, certain aspects, like establishing a flat hierarchy and fostering a blame-free environment, show variability in their effectiveness, suggesting room for improvement.

Figure A I.1 Maturity Assessment Report

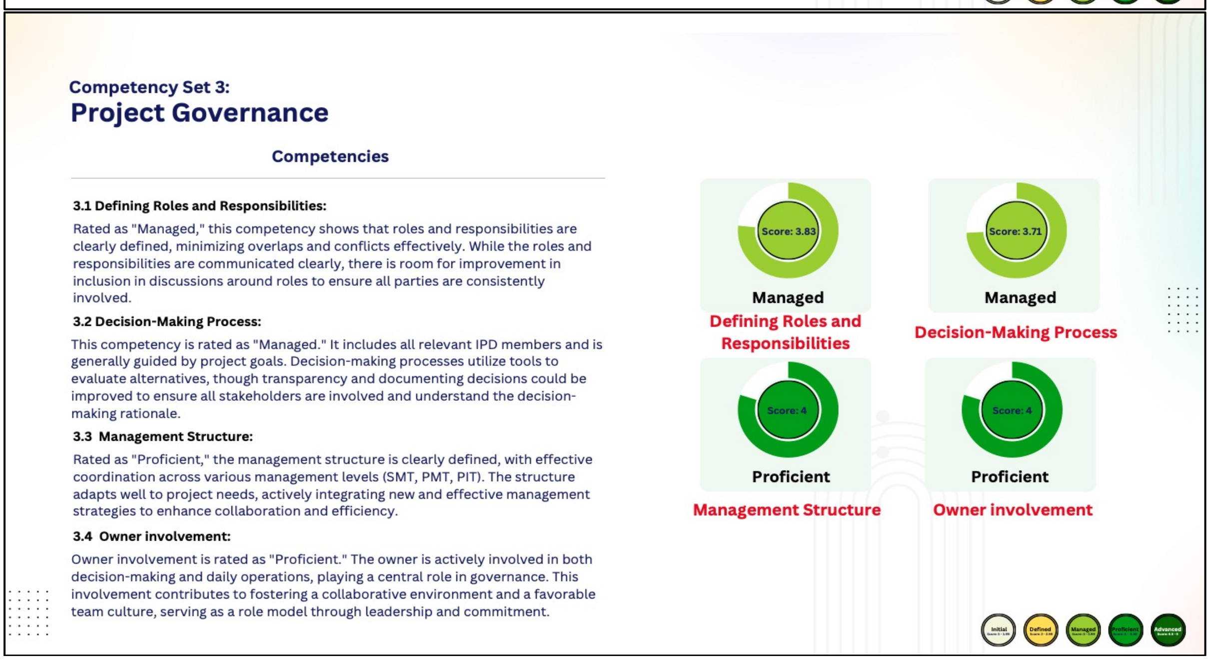


Figure A I.1 Maturity Assessment Report (continued)

Figure A I.1 Maturity Assessment Report (continued)

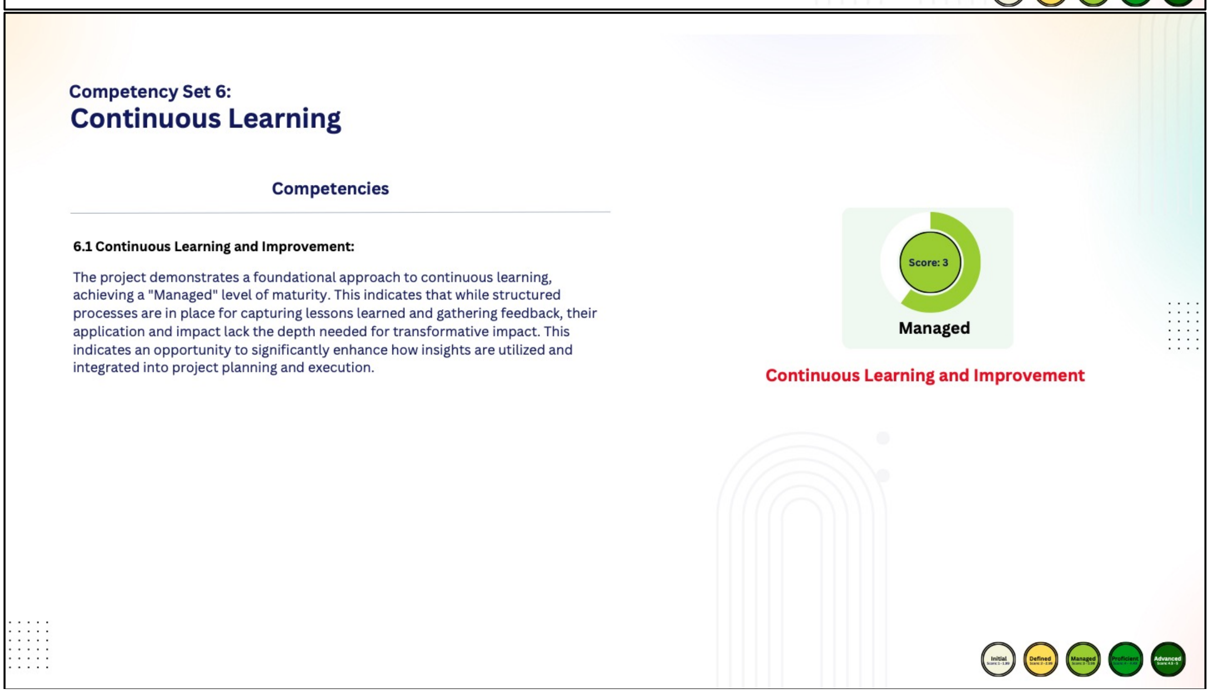


Figure A I.1 Maturity Assessment Report (continued)

APPENDIX J

IPD READINESS ASSESSMENT TOOL (IPD-ReAT) – CHAPTER 4

Capability Sets	#	Capabilities	#	Readiness Indicator	Questions	Answer			Score	Aggregate Score
						Yes	No	I Do Not Know	No, I Do Not Know: 0 Yes: 1	
Understanding and Facilitation	1.1	IPD Comprehension	1.1.1	Understanding of IPD Principles and Processes	Does the project team have a clear understanding of IPD principles?	☐	☐	☐		
			1.1.2	Recognition of the Relevance of IPD to Project Success	Does the project team recognize the differences between IPD and traditional delivery methods in contributing to the project's success?	☐	☐	☐		
			1.1.3	Integration of IPD in Execution	Are IPD principles detailed and incorporated into the project execution plans?	☐	☐	☐		
	1.2	Facilitation	1.2.1	Assessment of Gaps in Understanding of IPD Practices	Is a detailed assessment planned at the project's outset to identify knowledge gaps in IPD practices?	☐	☐	☐		
			1.2.2	Training of on IPD Tools	Is a training program on IPD tools and techniques during the onboarding process included in the initial plans?	☐	☐	☐		
					Is there a plan to continue training and skill development in IPD and Lean practices throughout the project?	☐	☐	☐		
			1.2.3	Contribution of Facilitation to Culture Establishment	Are specific facilitation practices planned to support the team culture?	☑	☐	☐		
	1.3	Building and Sustaining Teams	1.3.1	Establishment of Team Culture	Is there a plan to allocate resources to foster a unified and cohesive team culture?	☐	☐	☐		
					Is fostering a unified team culture recognized as a key driver for your project's success in the planning documents?	☐	☐	☐		
			1.3.2	Implementation of Flat Hierarchy	Is a flat hierarchy, where IPD team members share equal authority within each management level, planned for your project?	☐	☐	☐		
					Are joint management responsibilities considered in the project's initial organizational setup?	☐	☐	☐		
			1.3.3	Open Communication	Is there a plan to encourage open and direct communication among all team members?	☐	☐	☐		
			1.3.4	Encouragement of Participation	Is there a strategy to encourage active participation from all team members during the project?	☐	☐	☐		
					Have mechanisms been included in the project's initial plans to foster engagement between team members?	☐	☐	☐		
Goal Setting and Contract Development	2.1	Developing Project Goals (Validation Process)	2.1.1	Validation Process	Is there a structured validation process planned at the initial stage of the project?	☐	☐	☐		
			2.1.2	Collaboration in Validation	Are there strategies in place to enhance collaboration during the validation process?	☐	☐	☐		
			2.1.3	Participation in Validation	Will all IPD team members "IPD signatories" be included in the validation process?	☐	☐	☐		
					Is active participation and continuous presence from all IPD team members "IPD signatories" required in the validation process?	☐	☐	☐		
			2.1.4	Impact of validation on team culture	Are there planned activities to leverage the validation process as a team-building opportunity?	☐	☐	☐		
			2.1.5	Defining Project Goals	Will essential project goals be defined during the validation process?	☐	☐	☐		
					Is there a strategy to ensure that all team members are well-informed and understand project goals after validation?	☐	☐	☐		
			2.1.6	Clarity and Comprehensiveness of Validation Report	Is producing a clear and comprehensive validation report identified as one of the goals of the validation process?	☐	☐	☐		
	2.2	Defining project values	2.2.1	Defining Core Values	Will the project's core values be defined early in the project?	☐	☐	☐		
					Is there a plan to continuously revisit and reinforce these values?	☐	☐	☐		
			2.2.2	Communication of Values	Is there a plan to ensure the project's core values are clearly communicated to all members?	☐	☐	☐		
			2.2.3	Reference to Values in Decision-making	Is there a planned mechanism to ensure that all decisions align with the project's core values?	☐	☐	☐		
	2.3	Contract Formulation	2.3.1	Participation in Contract Formulation	Will all IPD project members be involved in the contract formulation process?	☐	☐	☐		
			2.3.2	Integration of All IPD Principles	Will the contract be structured to reflect all IPD principles?	☐	☐	☐		
			2.3.3	Utilization of Facilitation Means	Is there a strategy to ensure active involvement from all stakeholders during the contract formulation process?	☐	☐	☐		
					Will facilitation methods, such as workshops and expert consultations, be used to support the contract development process?	☐	☐	☐		
			2.3.4	Contract Optimization	Is there a plan to adjust the standard contract forms to meet the specific needs of this project?	☐	☐	☐		
					Has the contract been tailored to facilitate sustained collaboration in all scenarios, whether the project is over or under the target cost?	☐	☐	☐		

Figure A J.1 IPD Readiness Assessment Tool (IPD-ReAT)

Capability Sets	#	Capabilities	#	Readiness Indicator	Questions	Answer			Score	Aggregate Score
						Yes	No	I Do Not Know	No, I Do Not Know: 0 Yes: 1	
Project Governance	3.1	Defining Roles and Responsibilities	3.1.1	Definition of roles and responsibilities	Is there a strategy for defining the roles and responsibilities among the project team?	☐	☐	☐		
			3.1.2	Overlaps and conflicts	Is there a mechanism in place to minimize overlaps within team roles?	☐	☐	☐		
			3.1.3	Discussion of Roles and Responsibilities	Are discussions planned to establish clear roles and responsibilities among all parties and ensure their consensus?	☐	☐	☐		
			3.1.4	Communication of Roles and Responsibilities	Are there mechanisms in place to ensure every team member is informed and aligned with their and others' roles?	☐	☐	☐		
			3.1.5	Understanding of Roles and Accountability	Is accountability clearly defined and understood by all team members?	☐	☐	☐		
	3.2	Establishing Decision-Making Process	3.2.1	Inclusion in Decision-Making	Will all relevant stakeholders be involved in the decision-making process?	☐	☐	☐		
			3.2.2	Transparency in Decision-Making	Are the decision-making processes clearly described and transparent?	☐	☐	☐		
			3.2.3	Guidance by Project Goals	Has a mechanism or procedure been established to ensure that all decisions are guided by the overarching project goals?	☐	☐	☐		
			3.2.4	Use of Decision Tools	Have decision-support tools been identified?	☐	☐	☐		
			3.2.5	Documentation of decisions	Are mechanisms in place to comprehensively document all decisions, providing clear context and rationale?	☐	☐	☐		
					If yes: Do these mechanisms provide clear context and rationale?	☐	☐	☐		
	3.3	Establishing Management Structure	3.3.1	Management Structure	Will a multilayer management structure (SMT, PMT, PIT) be established for the project?	☐	☐	☐		
			3.3.2	Coordination of Activities Across Management Levels	Have activities and duties been coordinated effectively across management levels?	☐	☐	☐		
			3.3.3	Coordination of Decisions	Are mechanisms in place to ensure that decisions are consistently aligned and effectively communicated across all management levels?	☐	☐	☐		
	3.4	Owner involvement	3.4.1	Involvement in Decision-Making	Will the owner be actively involved in the project decision-making processes?	☐	☐	☐		
					Are the owner's role and responsibilities clearly established?	☐	☐	☐		
			3.4.2	Involvement in Day-to-Day Operations	Will the owner be directly involved in the day-to-day operations of the project?	☐	☐	☐		
			3.4.3	Role in Project Governance	Will the owner be involved in the governance of the project?	☐	☐	☐		
			3.4.4	Support for the IPD Model	Does the owner understand and support the implementation of the IPD model?	☐	☐	☐		
			3.4.5	Contribution to Collaborative Environment	Is the owner planning to support a collaborative project environment through ongoing positive engagement and by addressing barriers between team members?	☐	☐	☐		
			3.4.6	Contribution to Team Culture	Does the owner understand how their mindset, actions, and leadership style influence the likelihood of fostering a positive team culture throughout the project?	☐	☐	☐		
			3.4.7	Leadership	Is the owner committed to actively leading and championing the IPD approach throughout the project's duration?	☐	☐	☐		

Figure A J.1 IPD Readiness Assessment Tool (IPD-ReAT) (continued)

Capability Sets	#	Capabilities	#	Readiness Indicator	Questions	Answer			Score	Aggregate Score
						Yes	No	I Do Not Know	No, I Do Not Know: 0 Yes: 1	
Operational Excellence	4.1	Operational Culture	4.1.1	Promotion of Lean Practices	Will the use of lean practices be promoted in the project?	☐	☐	☐		
					Have specific Lean practices been identified and integrated into the project plan?	☐	☐	☐		
			4.1.2	Support for a Collaborative Work Environment	Does the project aim to create an operational culture that encourages teamwork and collective problem-solving?	☐	☐	☐		
			4.1.3	Adoption of a No-Blame Culture	Does the project aim to create an operational culture that encourages learning from mistakes without assigning blame?	☐	☐	☐		
	4.2	Operational Principles	4.2.1	Streamlining of Workflows	Is streamlining workflows identified as one of the core operational principles guiding the project's practices?	☐	☐	☐		
			4.2.2	Emphasis on Waste Reduction	Is minimizing waste identified as one of the core operational principles that will be ensured using different Lean tools such as Value Stream Mapping?	☐	☐	☐		
			4.2.3	Emphasis on Value Maximization	Is there a plan to ensure value maximization in all project decisions through mechanisms such as Choosing By Advantages (CBA), Target Value Design (TVD), or Value Engineering?	☐	☐	☐		
			4.2.4	Emphasis on Continuous Improvement	Is there a plan to regularly evaluate and enhance project practices?	☐	☐	☐		
	4.3	Tools	4.3.1	Use of BIM	Is there a plan to use BIM?	☐	☐	☐		
					If yes: Will it be used for Capturing and Representing?	☐	☐	☐		
					If yes: Will it be used for Planning and Designing?	☐	☐	☐		
					If yes: Will it be used for Simulating and Quantifying?	☐	☐	☐		
					If yes: Will it be used for Constructing and Fabricating?	☐	☐	☐		
					If yes: Will it be used for Operating and Maintaining?	☐	☐	☐		
					If yes: Will it be used for Monitoring and Controlling?	☐	☐	☐		
					If yes: Will it be used for Linking and Extending?	☐	☐	☐		
					Is there a plan to train team members and enhance their BIM capabilities?	☐	☐	☐		
			4.3.2	Enhancement of Collaboration and Communication through BIM	Is there a strategy in place to leverage BIM to enhance collaboration and communication within the project?	☐	☐	☐		
			4.3.3	BIM as Information Source	Are there measures in place to ensure the integrity and accessibility of data within the BIM environment?	☐	☐	☐		
			4.3.4	Use of Lean Tools	Is there a plan to use Lean tools to streamline workflows and maximize project value?	☐	☐	☐		
			4.3.5	Integration of Lean Tools and Techniques Into Operational Practices.	If yes: Will the Last Planner System be used?	☐	☐	☐		
					If yes: Will the Plus/Deltas be used?	☐	☐	☐		
					If yes: Will the A3 and 5Why be used?	☐	☐	☐		
					If yes: Will the 5S be used?	☐	☐	☐		
					If yes: Will the Target Value Design (TVD) be used?	☐	☐	☐		
					If yes: Will the Decision Matrix be used?	☐	☐	☐		
	4.4	Dynamics	4.4.1	Structuring of Multidisciplinary Teams	Will the teams (PITs) be structured inclusively to integrate a broad range of disciplines?	☐	☐	☐		
			4.4.2	Flexibility of Team Formations	Are mechanisms in place to restructure teams as needed?	☐	☐	☐		
			4.4.3	Definition of Responsibilities Within Teams	Is there a plan to document and communicate responsibilities within teams to ensure clarity and accountability?	☐	☐	☐		
			4.4.4	Decision-Making Authority Within Teams	Will team members be empouwered to make decsions related to their tasks?	☐	☐	☐		
	4.5	Engagement	4.5.1	Use of Formal Communication	Will the use of formal communication channels be limited to official notices or legal correspondences?	☐	☐	☐		
			4.5.2	Direct and Informal Engagement	Have communication channels been put in place to encourage direct and informal engagement among team members?	☐	☐	☐		
					Have specific platforms or digital tools been identified to facilitate informal communication within the project?	☐	☐	☐		
			4.5.3	Communication and Engagement Strategies	Is there an inclusive communication strategy in place to keep all team members, including on-site personnel, well-informed and aligned with project objectives?	☐	☐	☐		
	4.6	Work Environment	4.6.1	Frequency of Big Room Meetings	Will Big Room meetings be held frequently, whether physical or virtual?	☐	☐	☐		
			4.6.2	Big Room Setup	Will the Big Room be designed as a flexible, collaborative space?	☐	☐	☐		
					Will the Big Room be designed as a no-title zone to encourage participation and interaction among all team members?	☐	☐	☐		
			4.6.3	Incorporation of Advanced Tools and Techniques in Big Room	Have advanced tools been identified to facilitate the big room process?	☐	☐	☐		

Figure A J.1 IPD Readiness Assessment Tool (IPD-ReAT) (continued)

Capability Sets	#	Capabilities	#	Readiness Indicator	Questions	Answer: Yes	Answer: No	Answer: I Do Not Know	Score (No, I Do Not Know: 0 Yes: 1)	Aggregate Score
Management and Oversight	5.1	Information Management	5.1.1	Information Structure	Has an information hierarchy or structure been identified to ensure clarity and easy accessibility?	☐	☐	☐		
					Has an information security framework been identified?	☐	☐	☐		
			5.1.2	Information Sharing	Have digital platforms been identified to facilitate efficient dissemination?	☐	☐	☐		
					Have systems, tools, or protocols been selected to enable effective and secure information sharing?	☐	☐	☐		
			5.1.3	Access to Data	Will real-time access to project data be ensured for project members to facilitate timely decisions and responsiveness?	☐	☐	☐		
			5.1.4	Use of Advanced Technologies	Has the use of advanced technologies, such as AI, VR, and Digital Twins, been explored to enhance data utilization and support decision-making within the project?	☐	☐	☐		
	5.2	Financial Practices	5.2.1	Financial Discussions	Will all IPD team members "IPD signatories" be included in financial discussions?	☐	☐	☐		
			5.2.2	Financial Transparency	Will open-book accounting be employed to manage financial activities throughout the project?	☐	☐	☐		
					Are there measures in place to maintain clarity and transparency in financial reporting for all stakeholders?	☐	☐	☐		
			5.2.3	Financial Responsibility	Are there mechanisms in place to establish and track both shared and individual financial responsibilities among team members?	☐	☐	☐		
			5.2.4	Use of Incentive Mechanisms	Is there a plan to establish incentive mechanisms for the project?	☐	☐	☐		
					Have incentive mechanisms been designed to specifically sustain collaboration throughout the project and in different scenarios?	☐	☐	☐		
			5.2.5	Financial Decision-Making Tools	Have financial planning tools be identified for use on the project?					
	5.3	Risk Practices	5.3.1	Risk Management Practices	Is there a protocol to ensure all IPD team members, "IPD signatories," are involved in risk management activities?	☐	☐	☐		
			5.3.2	Frequency of Risk Management Practices	Is there a schedule or frequency established for conducting these risk assessments?	☐	☐	☐		
			5.3.3	Use of Collaborative Tools	Will a risk register be developed for the project to identify, assess, and manage risks?	☐	☐	☐		
	5.4	Performance Monitoring	5.4.1	Use of Dashboards	Is there a plan to implement dashboards to visualize a broad range of performance metrics such as budget, schedule, safety, and culture?	☐	☐	☐		
			5.4.2	Data Collection and Analysis	Are there guidelines or systems in place to ensure consistent data collection and analysis?	☐	☐	☐		
					Is there a plan to standardize data collection across all project disciplines?	☐	☐	☐		
Continuous Learning	6.1	Continuous Learning and Improvement	6.1.1	Capture of Lessons Learned	Will lessons learned be captured throughout the project?	☐	☐	☐		
					Is there a specific mechanism in place to capture and document lessons learned throughout the project's duration?	☐	☐	☐		
			6.1.2	Analysis of IPD Practices Feedback	Is there a plan to regularly gather and analyze feedback on IPD practices using tools like surveys to identify areas for improvement?	☐	☐	☐		
			6.1.3	Analysis of Stakeholder Feedback	Will stakeholder feedback be regularly collected and anayzed?	☐	☐	☐		
			6.1.4	Assessment of Client Satisfaction	Will client satisfaction be surveyed and analyzed throughout the project?					

Figure A J.1 IPD Readiness Assessment Tool (IPD-ReAT) (continued)

APPENDIX K

READINESS ASSESSMENT REPORT – CHAPTER 4

IPD Readiness Assessment Report

Date: December 01, 2024

Executive Summary:
The IPD Readiness Assessment for the evaluates the preparedness for implementing Integrated Project Delivery (IPD) across six key capability sets: Understanding and Facilitation, Goal Setting and Contract Development, Project Governance, Operational Excellence, Management and Oversight, and Continuous Learning. Readiness levels are assessed on a scale from Emergent (0.0 - 1.0), Low (1.1 - 2.0), Moderate (2.1 - 3.0), High (3.1 - 4.0), to Optimal (4.1 - 5.0). This assessment highlights IPD Comprehension and Owner Involvement at optimal readiness, showcasing strong leadership and integration of IPD principles. High readiness in Facilitation, Defining Project Goals, Defining Project Values, Operational Culture, and Work Environment demonstrates robust planning and effective preparatory measures. However, emergent readiness in Defining Roles and Responsibilities, Establishing Decision-Making Processes, and Performance Monitoring, alongside low readiness in Contract Formulation, Dynamics, Engagement, Information Management, Financial Practices, and Risk Practices, indicates significant areas for development. The mix of readiness levels across the capability sets points to both well-prepared aspects and others needing substantial improvement to support effective IPD implementation.

Understanding and Facilitation: This capability set shows mixed readiness levels. IPD Comprehension is optimal, with effective integration of IPD principles. Facilitation is well-prepared with initial training and supportive cultural practices in place, though ongoing training is lacking. Building and Sustaining Teams has moderate readiness, with plans for fostering team culture and open communication, but lacks strategies for flat hierarchy and full team engagement

Goal Setting and Contract Development: This capability set shows varying readiness levels. High readiness in goal validation and defining project values, with strong plans for collaboration and reinforcing core values. However, readiness for contract formulation is low, with limited stakeholder involvement and insufficient integration of IPD principles.

Project Governance: This capability set shows varied readiness levels. Owner involvement demonstrates high readiness with active participation in governance. Management structure readiness is moderate, while defining roles and responsibilities and decision-making processes show emergent readiness with gaps in role clarity and transparency.

Operational Excellence: This capability set also shows varied readiness levels. High readiness is seen in Operational Culture and Work Environment, with strong collaboration plans and frequent Big Room meetings. Tools and Operational Principles are moderately ready, with BIM use planned but limited training and workflow streamlining. Dynamics and Engagement show low readiness, lacking inclusive team structures and effective communication strategies.

Management and Oversight: This capability set shows predominantly low readiness levels. Information Management and Financial Practices demonstrate limited planning, with missing structures for secure information sharing and mechanisms for financial accountability. Risk Practices also show low readiness, lacking protocols for collaborative risk management and regular assessments. Performance Monitoring readiness is emergent, with no plans for dashboards or consistent data collection systems.

Continuous Learning: This capability set demonstrates moderate readiness, with plans to capture lessons learned and intentions to analyze IPD practices and client satisfaction. However, structured mechanisms for documentation and broader stakeholder feedback analysis are lacking.

Prepared by: Ahmad Arar, Erik Poirier, Sheryl Staub-French

Capability Set 1:
Understanding and Facilitation

1.1 IPD Comprehension:

The team's understanding of IPD principles and processes is at an optimal readiness level, with a score of 4.17. The project team demonstrates a clear grasp of IPD principles and acknowledges their distinct advantages over traditional delivery methods in contributing to project success. The incorporation of these principles into project execution plans is effectively managed, ensuring a solid foundation for IPD implementation.

1.2 Facilitation:

The readiness level for Facilitation is high, with an average score of 3.13. The project plans include training on IPD tools and techniques during the onboarding process. Specific facilitation practices intended to support team culture are also planned. However, ongoing training throughout the project and a detailed assessment at the outset to identify knowledge gaps in IPD practices are not planned.

1.3 Building and Sustaining Teams:

The readiness level for Building and Sustaining Teams is moderate, with a score of 2.86. Resources are planned to foster a unified and cohesive team culture. Although this aspect of team culture is not emphasized as a key driver for project success, there are intentions to support it. Plans to encourage open and direct communication and consider joint management responsibilities are in place. However, a flat hierarchy ensuring equal authority among IPD team members is not fully planned, and comprehensive strategies to encourage active participation from all team members are lacking.

Figure A K.1 Readiness Assessment Report

Capability Set 2:
Goal Setting and Contract Development

2.1 Developing Project Goals:

The readiness level for Developing Project Goals is high, with a score of 3.13. The project plans include a structured validation process at the initial stage, along with well-defined strategies to ensure collaboration and participation of all IPD team members during this phase. Essential project goals will be defined during the validation, and a clear and comprehensive validation report is identified as a critical output. However, there are no specific plans to leverage the validation process as a team-building opportunity. Additionally, the active and continuous presence of all IPD team members during the validation process is not fully ensured.

2.2 Defining project values:

The readiness level for Defining Project Values is high, with a score of 3.13. The project plans include early definition of core values and a commitment to continuously revisit and reinforce these values throughout the project duration. However, the plans lack specific strategies to ensure that the project's core values are clearly communicated to all team members. Additionally, mechanisms to ensure that all decisions align with the project's core values are not fully established.

2.3 Contract Formulation:

The readiness level for Contract Formulation is low, with a score of 1.25. Not all IPD project members are planned to be involved in the contract formulation process, nor is there a strategy to ensure active stakeholder involvement. While there is an intention to structure the contract to reflect all IPD principles, there are no apparent plans to employ facilitation methods such as workshops and expert consultations to support the contract development process. Furthermore, there are no plans to adjust standard contract forms to meet specific project needs and facilitate sustained collaboration under different cost scenarios.

Capability Set 3:
Project Governance

3.1 Defining Roles and Responsibilities:
The readiness level for Defining Roles and Responsibilities is emergent, with a score of 1.00. Currently, there is no overarching strategy to define roles and responsibilities among the project team. While some discussions to establish clear roles and ensure consensus among all parties are planned, mechanisms to minimize role overlaps, communicate roles effectively, and define accountability across the team are not in place.

3.2 Decision-Making Process:
The readiness level for Establishing the Decision-Making Process is emergent, with a score of 0.83. While plans are in place to involve all relevant stakeholders in the decision-making process, there are no established mechanisms to ensure transparency in these processes. Furthermore, there are no procedures in place to guide decisions according to overarching project goals. Additionally, the project lacks identified decision-support tools, and there is no strategy for comprehensive documentation of decisions to provide clear context and rationale.

3.3 Management Structure:
The readiness level for Establishing Management Structure is moderate, with a score of 2.50. Plans are in place to establish a multilayer management structure (SMT, PMT, PIT) for the project. However, while some coordination of activities across management levels is planned, there are no mechanisms in place to ensure that decisions are consistently aligned and effectively communicated across all management levels.

3.4 Owner involvement:
The readiness level for Owner Involvement is optimal, with a score of 4.1. Plans are well-established for the owner to be actively involved in decision-making, day-to-day operations, and project governance. The owner is also committed to leading and championing the IPD approach throughout the project's duration. Support for the IPD model is strong, and the owner is prepared to enhance the collaborative environment through ongoing engagement and addressing barriers between team members. However, there is no clear understanding of how the owner's mindset, actions, and leadership style will influence the team culture.

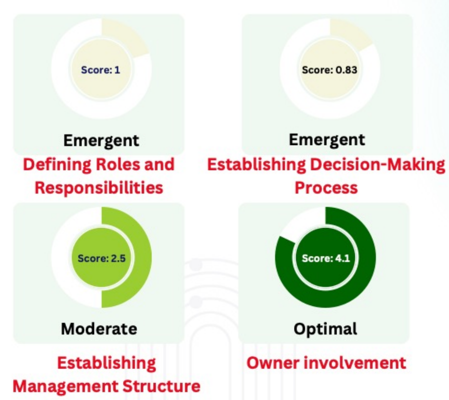


Figure A K.1 Readiness Assessment Report (continued)

Capability Set 4:

Operational Excellence

4.1 Operational Culture:

The readiness level for Operational Culture is high, with a score of 3.75. Plans are in place to promote an operational culture that supports teamwork, collective problem-solving, and learning from mistakes without assigning blame. While lean practices are intended to be promoted within the project, specific Lean practices have not been clearly identified and integrated into the project plan.

4.2 Operational Principles:

The readiness level for Operational Principles is moderate, with a score of 2.50. Plans are in place to ensure value maximization in all project decisions through methods like Choosing By Advantages (CBA), Target Value Design (TVD), and Value Engineering. However, streamlining workflows and minimizing waste, though recognized as core operational principles, lack specific plans for implementation using Lean tools like Value Stream Mapping. Additionally, the project lacks a structured approach for the regular evaluation and enhancement of project practices.

4.3 Tools:

The readiness level for Tools is moderate, with a score of 2.64. The project plans extensive use of Building Information Modeling (BIM) for capturing, representing, planning, designing, and fabricating, but has limited plans for its use in simulating and quantifying, operating and maintaining, and monitoring and controlling. There is also a strategy in place to leverage BIM to enhance collaboration and communication within the project. Nonetheless, there are no plans to train team members to enhance their BIM capabilities, nor are there measures in place to ensure the integrity and accessibility of data within the BIM environment. While there is an intention to use Lean tools like the Last Planner System, Plus/Deltas, A3, 5Why, and TVD to streamline workflows and maximize project value, the integration of these tools into operational practices is not fully planned.

Continue -Capability Set 4:

Operational Excellence

4.4 Dynamics:

The readiness level for Dynamics is low, with a score of 1.25. While there is a plan for multidisciplinary teams (PITs) to be empowered to make decisions related to their tasks, they are not structured inclusively to integrate a broad range of disciplines. Additionally, there are no mechanisms in place to restructure teams as needed, and there is no plan to document and communicate responsibilities within teams to ensure clarity and accountability.

4.5 Engagement:

The readiness level for Engagement is low, with a score of 1.25. The project includes plans for direct and informal engagement among team members, with specific platforms and digital tools identified to facilitate this communication. However, the use of formal communication channels is not specifically limited to official notices or legal correspondences, and there is no inclusive communication strategy in place to keep all team members, including on-site personnel, well-informed and aligned with project objectives.

4.6 Work Environment:

The readiness level for the Work Environment is high, with a score of 3.75. Plans are in place to frequently hold Big Room meetings, whether physically or virtually, and to design the Big Room as a flexible, collaborative space without titles to encourage active participation and interaction among all team members. However, there are no plans to incorporate advanced tools and techniques to facilitate the Big Room process.

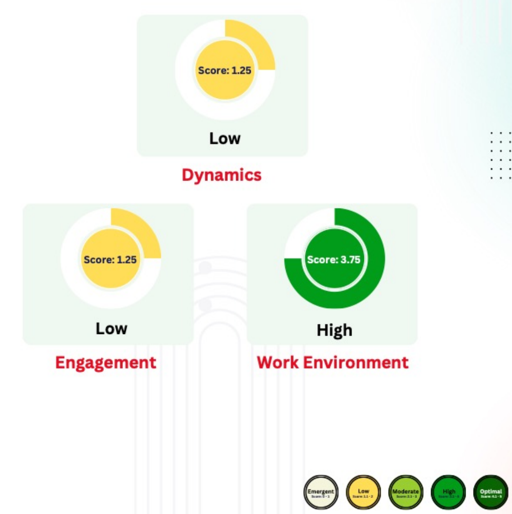


Figure A K.1 Readiness Assessment Report (continued)

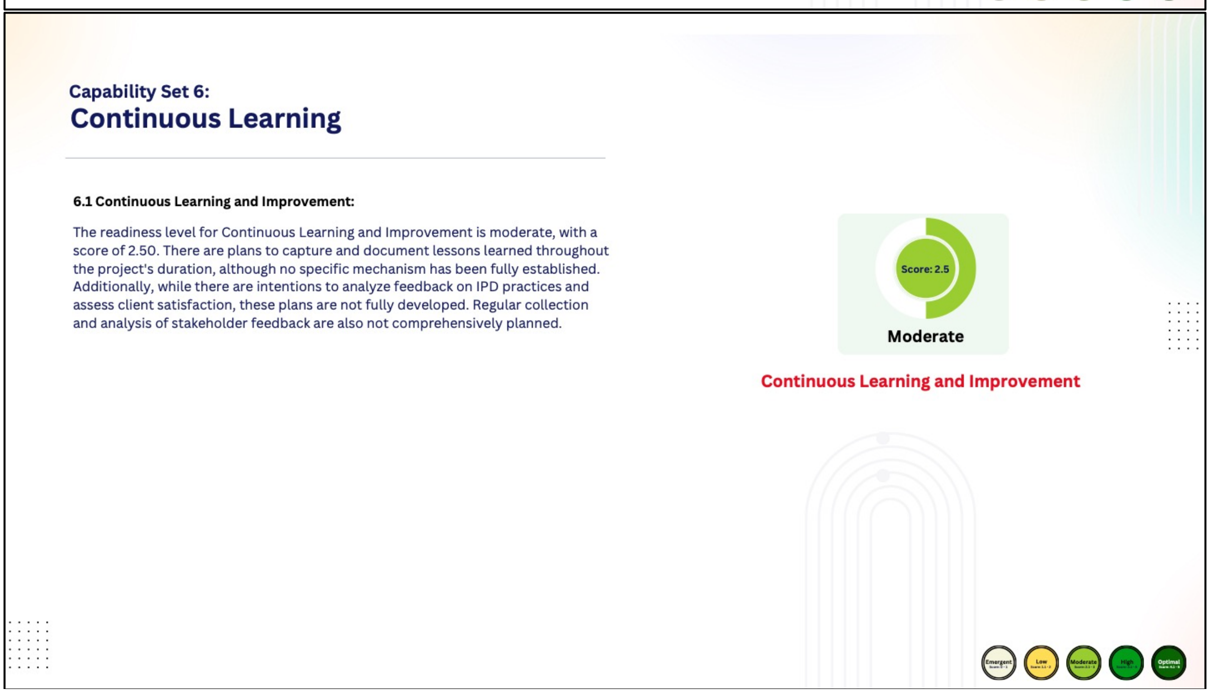


Figure A K.1 Readiness Assessment Report (continued)

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