Evolutionary model for gradual transition to Integrated Project Delivery (IPD)

Modelo evolutivo para la transición gradual a la Entrega Integrada de Proyectos (IPD)

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Abstract

Over the years, construction projects have been developed and delivered through traditional delivery methods. However, traditional delivery methods have been considered ineffective to achieve the real project goals. Integrated and collaborative models, such as Integrated Project Delivery (IPD), a delivery method based on relational contracts, has attracted growing interest in both academia and industry, but still scarce in Architecture Engineering, and Construction (AEC). Most prior research emphasized the identification of barriers and challenges to implementing IPD and few studies focused on developing strategies to overcome those constraints. A limited number of studies have addressed how to reap the benefits of IPD in AEC environments where collaboration between stakeholders is poor. This research investigates how to integrate IPD into AEC projects when collaboration is still limited. An "IPD Evolutionary Model" and guidelines for its implementation were developed for applications in such environments. Design Science Research was the research approach adopted in this study to discuss and evaluate the proposed model. The model emphasizes an evolutionary and flexible process for the IPD application in AEC projects. The model postulates the desirable and required IPD elements according to the levels of application difficulty, emphasising stakeholders' readiness for using it and the gradual introduction of IPD in such environments.

Keywords: Integrated Project Delivery; Integration; Collaborative Systems; Innovative Projects; Multiparty Agreements.

Resumen

Por años, los proyectos de construcción se han desarrollado y entregado usando métodos de entrega tradicionales. Sin embargo, esos métodos se han considerado ineficaces para lograr los objetivos reales del proyecto. Un modelo integrado y colaborativo, como la Entrega Integrada de Proyectos (IPD, por su sigla en inglés), un método de entrega basado en contratos relacionales ha atraído un interés creciente tanto en la academia como en la industria, pero aún escaso en Arquitectura, Ingeniería y Construcción (AIC). La mayoría de las investigaciones anteriores enfatizan en la identificación de las barreras y desafíos para implementar la IPD y pocos estudios se enfocan en desarrollar estrategias para superar esas limitaciones. Un número limitado de estudios aborda el cómo aprovechar los beneficios de la IPD en entornos AIC donde la colaboración entre las partes interesadas es deficiente. Esta investigación busca la forma de integrar la IPD en los proyectos de AIC cuando la colaboración aún es limitada. Se desarrolló un "Modelo Evolutivo de la IPD" y los lineamientos para su implementación para aplicaciones en tales ambientes. La Investigación en Ciencias del Diseño fue el enfoque adoptado en este studio para discutir y evaluar el modelo propuesto. El modelo enfatiza un proceso evolutivo y flexible para la aplicación de la IPD en proyectos en AIC. El modelo postula los elementos de IPD deseables y requeridos según los niveles de dificultad de aplicación, enfatizando la disposición de las partes interesadas para utilizarlo y la introducción gradual de la IPD en tales ambientes.

Palabras clave: Entrega Integrada de Proyectos; Integración: Sistemas colaborativos; Proyectos Innovadores; Acuerdos Multipartes.

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1. Introduction

Over the years, several studies have recommended new project delivery strategies and methods, such as Integrated Project Delivery (IPD1). IPD has the potential to develop innovative construction products and services, to bring about significant growth in productivity in the Architecture Engineering, and Construction (AEC) industry (Alinezhad et al., 2020); (Engebø et al., 2020). However, adopting IPD has been slow, considering the application and success of this delivery system in various projects (Hall and Scott, 2019). Most projects developed within AEC still adopting traditional delivery methods, such as Design-Bid-Build (DBB), which are considered ineffective to overcome all requirements in the early stages of a project (Hosseini et al., 2018).

DBB has been described as a delivery method that results in a poor connection between interdependent subsystems, sequential relationship between design and production stages, low efficiency for stakeholders, conflicting goals, difficulty of parties in accomplishing contractual costs, and time requirements (Mesa et al., 2016). Due to the overriding negative bias of DBB and low efficiency to introduce pre-construction services, most key decisions are not considered in the early project stages, and those information gaps become risk factors during the construction stage (Jadidoleslami et al., 2019). For this reason, researchers and AEC practitioners have made considerable efforts to introduce appropriate and collaborative delivery systems, such as IPD, especially for complex projects (Lee et al., 2014). IPD has been devised to overcome problems and constraints of DBB, and to promote integration among parties to improve project outcomes (Zhang and Hu, 2018).

IPD is strongly based on the early involvement of stakeholders, which creates opportunities for collaboration, establishing mutual benefits and rewards, fiscal transparency, open communication and collective ownership behaviour (Lee et al., 2014). Nonetheless, a relatively small number of large and complex projects developed by private owners and stakeholders who have expertise in collaborative maturity environments in the USA have fully adopted IPD (Alinezhad et al., 2020); (Hamzeh et al., 2019); (Osburn et al., 2018). These projects have shown improvements in project performance through strong collaboration and sharing value systems (AIA, 2012); (Evans et al., 2021).

In contrast, IPD is considered a risky business in the AEC industry, and still rare in environments where collaborative practices are not effective, or even absent, especially in contexts where DBB has been widely used (Whang et al., 2019); (Hamzeh et al., 2019). Both public and private owners are more familiarized with DBB and face constraints to move from traditional delivery methods to relational contracts, which are necessary for IPD (Li and Ma, 2017); (Verheij and Augenbroe, 2006).

Existing studies have analysed the challenges of IPD implementation, in terms of conditions in different regions of the world and local rules (Kahvandi et al., 2019). Several factors have dissuaded public and private owners from adopting IPD, including legal barriers and government laws that establish mandatory traditional DBB; the lack of knowledge with integrated and collaborative project delivery approaches; lack of trust between stakeholders; insufficient evidence of the return on investment; and few reports on successful cases of implementation of IPD in a wide range of contexts and countries (Kahvandi et al., 2020), (Kahvandi , 2019); (Li and Ma, 2017). The prerequisites required for IPD implementation are mismatched with DBB and it has scarcely been used in the AEC industry (Alinezhad et al., 2020). However, opportunities to apply IPD principles can lead to reducing existing barriers of traditional contracts (Kahvandi et al., 2019).

Changing the culture of construction project delivery is challenging and requires a transition process to overcome constraints and achieve positive business results (Durdyev et al., 2019). Experiences regarding how to organize and lead teams to deliver an IPD project successfully are still unknown in various places and not widespread within AEC (Alinezhad et al. 2020). Although some studies describe the IPD characteristics and principles to establish collaboration and integration, they do not provide empirical insights and guidelines prescribing how to overcome those constraints, and how IPD can be gradually applied from these elements in different collaboration environments (Hamzeh et al., 2019); (Osburn et al., 2018). Furthermore, the real value of

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IPD is still unclear, and not fully understood throughout the AEC (Whang et al., 2019), suggesting that little thought has gone into "how" and "whether" IPD can be successfully implemented in low-collaboration project situations.

The following research question guided the study: how can a transition be made from traditional to collaborative, relational construction project environments, to overcome the barriers and challenges for IPD application? The aim of this research is to propose an Integrated Project Delivery Evolutionary Model (IPDEM) and implementation guidelines for the transition from traditional construction project delivery models to IPD. Our assumption is that the evolutionary model is sufficiently adaptable and can pave the way for full-fledged IPD implementations in construction projects.

The paper is structured as follows: Section 2 presents literature review. Section 3 provides the research method. We present the discussion and results of our research in Section 4. Section 5 present the conclusion of the paper and provides limitations and future research.

2. Literature review

Traditional delivery methods, as mostly knowing as DBB, Design-Build (DB), Construction Management at Risk (CM at-Risk), so far has been widely applied in AEC. Those methods are applied around the world due local restrictions and laws, such as project costs and financial barriers, the level and complexity of the project, and poor experience of stakeholders to apply collaborative methods (Thomsen et al. 2009); (Park; Kwak, 2017).

However, traditional delivery methods present different design and construction phases, which are developed based on sequential phases: design, bidding and construction (Hosseini et al., 2018). It is generally assumed a low level of complexity and a high level of uncertainty during the design phase, which reflects on several of the problems during the construction phase (Ballard, 2012). Thus, the most important decisions are not analysed and considered from the beginning (Ashcraft Jr., 2014); (Kristensen et al., 2015), and construction process occur with little reliability and communication, lack of transparency among stakeholders (Matthews and Howell, 2005); (Koskela and Ballard, 2006); (Darrington et al., 2009); (Lee et al., 2014). Moreover, traditional delivery methods also do not provide any pre-construction services (Hellmund et al., 2008); (Mesa et al., 2016). For this reason, delivery methods, such as IPD, with integrated and collaborative systems have been considered as alternative to improve projects development (Azhar et al., 2014).

2.1 Critically review of integrated project delivery elements

IPD is described in the literature in two different ways (Figure 1), as a philosophy and a delivery method (AIA et al., 2010). Both approaches refer to three levels of collaboration: typical, enhanced, and required. In both cases, teams should be selected according to the qualification and the best value condition (AIA et al., 2010). IPD as a philosophy is also known as IPD-ish; IPD Lite; hybrid IPD; or Non-Multi-party IPD and is limited to the application of some IPD elements (principles and catalysts), according to the project particularities, to increase stakeholders' collaboration and achievement of project goals.

The main difference among IPD as a Philosophy and as a Delivery Method is the multi-party element (Zhang and Hu, 2018). IPD as a Delivery Method ("true" IPD/Multi-party IPD) requires a multi-party agreement or any other type of relational contract, which must be appropriate for fully supporting collaboration as the main requirement (AIA, 2007)[1].

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[1] AIA (2007) defines IPD 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 reduce waste and optimize efficiency through all phases of design, fabrication, and construction.

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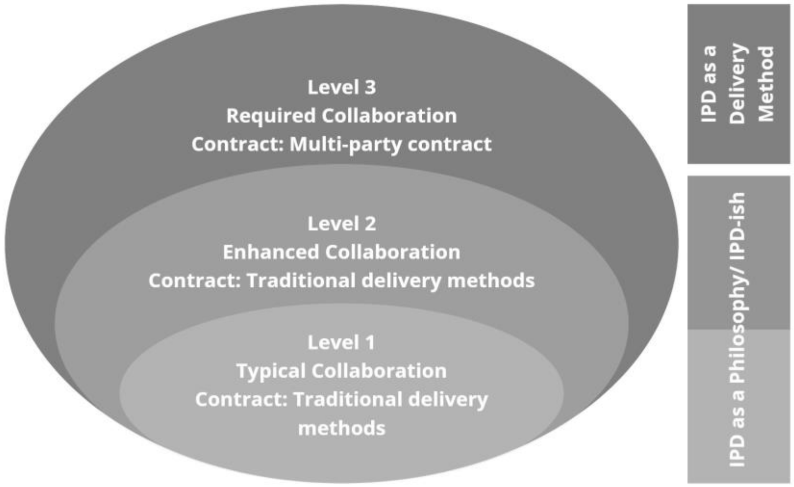

Figure 1. Collaboration Level. Source: (AIA et al., 2010).

IPD-ish comprises level 1 (typical) and level 2 (enhanced) levels of collaboration, respectively (AIA et al., 2010). Both levels demand lower collaborative and integrated practices than level 3 (required) (Zhang and Hu, 2018). At level 1, the model requires basic knowledge of integration concepts, and collaboration is not a required issue. At level 2, some contractual collaboration requirements are necessary, although not yet required, to implement IPD concepts in the design and construction process (AIA et al., 2010). At level 3, IPD is developed by the high level of collaboration and application of multi-party agreements (Moylan and Arafah, 2017). Level 3 is characterized by the complete application of all IPD principles, with early involvement of all stakeholders to enable wide collaboration, and commitment with the project goals (Mesa et al., 2016).

In general, the IPD is a flexible model, applicable through its elements (principles and catalysts), emphasising the collaborative and integrated work culture among parties to promote effective project delivery and a successful one (Sive , 2009), (Evans et al., 2021). According to (AIA et al., 2010), principles are classified into two categories: contractual (those that may be written into agreements) and behavioural (those that are necessary for project optimization). On the one hand, these principles are required elements in a multi-party IPD. On the other hand, catalysts are elements applied to enhance principles' effectiveness (AIA et al., 2010).

The literature on the IPD is unclear concerning principles and catalysts. Several studies do not distinguish principles from catalyst elements (AIA, 2007). Nevertheless, there is an association between the IPD principles and catalysts, and the latter contribute to the achievement of a specific principle (AIA et al., 2010).

An analysis between principles and catalysts from the IPD literature was previously carried out (Muianga, 2019);(Muianga and Granja, 2021) based on a literature review using AIA manuals (AIA, 2007), (AIA, 2010), and (AIA, 2012). Ten principles and nine catalysts were proposed (Figure 2).

The flexibility of the catalysts enables the principles to be better implemented using tools and means in which the stakeholders have extensive expertise, providing a significant opportunity for IPD effectiveness. Additional research synthetized the IPD's desirables and required elements (Sive, 2009); (Hall and Scott, 2019) (Figure 3). The collaboration of IPD at level 3 is achieved by the high level of collaboration and application of multi-party agreements, characterised by the complete application of all the IPD principles (Mesa et al., 2016). On the other hand, some of the elements required at level 3, are desirable at levels 1 and 2 of collaboration (Hall and Scott; 2019); (Sive, 2009).

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	Principles	Catalysts	Description	References
Behavioural	**Mutual respect and trust**	Pre-existing relationships between parties	The teams have an insight into the collaboration value and are committed to working together throughout the project, based on shared interests. There is a mutual respect and trust between teams that have previously cooperated.	AIA et. al., 2010; AIA, 2012
Behavioural	**Open communication**	Co-location (big-room)	Co-location facility face-to-face interaction and trust relations among parties in an innovative process. The availability of parties is well defined, enhancing communication and commitment.	AIA et. al., 2010; AIA, 2012
Behavioural	**Willing to collaborate**	Strong leadership and organization	The leadership may be attributed to the party with a strong ability to encourage participants to be willing to collaborate.	AIA et. al., 2010; AIA, 2007
Behavioural	**Early goal definition**	Financial incentives tied to goals	Mutual goals are defined and settled among all parties, aligned with individual interests. Incentive plans are aligned with goals to maintain teams focused and ensure performance during the project.	AIA et. al., 2010; AIA, 2007; AIA, 2012
Contractual	**Mutual benefit and reward / Shared financial risk and reward**	Multi-party agreement	Mutual benefits and rewards are established in a contract. The parties are committed to the project, resulting in behaviour, which emphasizes the best for the project.	AIA et. al., 2010; Lee et al., 2014
Contractual	**Liability Waivers between Key Participants**	Protection from litigation	Liability waivers occur when parties agree not to sue one another. They are encouraged to seek solutions to overcome problems, rather than attributing fault.	AIA, 2012; Lee et al., 2014
Contractual	**Key Participants Bound Together as Equals**	Multi-party agreement	All parties have the same importance in the project, supported by collaboration and consensus-based decisions.	AIA et. al., 2010; AIA, 2012
Contractual	**Early involvement of key participants**	Intensified planning	IPD process requires a rigorous and overarching planning at the early stages. All parties are involved early on. This allows pre-construction services, and also intensified planning.	Leicht et al., 2016
Contractual	**Fiscal transparency between key participants**	Implementation tools	Fiscal transparency increases trust and maintains contingence more visible and controllable. Tools are applied to maximizing value, minimizing non-value issues.	Darrington et al., 2009; Lee et al., 2014
Contractual	**Collaborative innovation and decision-making**	Appropriate technology visual inspection	Required for key participants to work together on important decisions, and encourages shared responsibility. The technological system increases collaboration, information sharing, and streamlining project design and construction.	Ashcraft Jr., 2016

Figure 2. IPD Elements: Principles and Catalysts. Source: Based on the literature and (Muianga and Granja, 2021)

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Principles	IPD-ish (level 1 and 2)	Delivery method (level 3)
Mutual respect and trust	Not considered	Required
Early goal definition	Not considered	Required
Liability Waivers between Key Participants	Not considered	Required
Fiscal transparency between key participants	Not considered	Required
Open communication	Desirable	Required
Collaborative innovation and decision-making	Required	Required
Mutual benefit and reward / Shared financial risk and reward	Desirable	Required
Early involvement of key participants	Desirable	Required
Willing to collaborate	Desirable	Required

Catalysts	IPD-ish (level 1 and 2)	Delivery method (level 3)
Implementation tools	Desirable	Required
Co-location (big-room)	Desirable	Required
Appropriate technology visual inspection	Not considered	Required
Multi-party agreement	Not considered	Required
Intensified planning	Desirable	Required
Strong leadership and organization	Desirable	Required

Figure 3. Desirable and Required IPD elements. Source: Based on (Sive, 2009); Hall and (Scott, 2019).

Collaborative innovation and decision-making are required elements, which should be effective in both IPD models, IPD-ish and pure. In IPD-ish, there is no distinction between principles or catalysts belonging to 1 or 2 levels of collaboration (AIA et al., 2010).

2.1.1 Implementation enablers

IPD implementation requires the identification of enablers and readiness of stakeholders (Osburn et al., 2018); (Whang et al., 2019). Enablers for organization, contract, and technologies are presented hereafter.

(i) Enablers for a contractual process: during the initial phases of project definition and criteria, IPD demands that stakeholders must exert influence to enact change (Whang et al., 2019). Contractual terms alignment, contractual strategies to ensure mutual interest and trust, risk control, shared reward and fiscal transparency without a no-blame culture throughout the project process are applied in this process (Lee et al., 2014). Participants create an open and collaborative environment as a way to comply with a requirement prescribed in the contractual term to achieve collaboration (AIA, 2012).

(ii) Enablers for the organization: changing the cultural paradigm is a prerequisite to improving social skills for teamwork (Lee et al., 2014). Thus, training opportunities need to be promoted to acquire essential skills before implementing IPD, which can be adapted to the use of the reward syste and establish mechanisms to eliminate risks during the implementation (Mollaoglu-Korkmaz et al., 2014). Through early involvement, intensified planning, and leadership, there are opportunities for a collaborative and efficient process, facilitating decision making and communication among stakeholders throughout project production (Leicht et al., 2016). Early involvement encourages integration and production from the same goals and qualification allows interaction and assertiveness of proposed solutions among teams (Leicht et al., 2016).

(iii) Enablers for technological aspects of IPD: strategies to accurately analyse constituents and understand the operability of a project's production are fundamental during IPD implementation. The information management platform should centralize shared databases with information related to the documents and progress of the project (Lee et al., 2014). This platform may contain information about the cost, schedule, quality, and scope of the project, facilitating the visualization, improving the collaboration, reliability, and precision of the production (Li and Ma, 2017). Although Building Information Modelling (BIM) has been mentioned as an additional mechanism for information integration in the project, it cannot be considered the main requirement for the effectiveness of technological aspects on IPD projects (Elgaish et al., 2021).

2.3 Readiness of stakeholders to implement IPD

The steps to conduct pre-contracts of IPD focus on the initial organization of a project to achieve readiness of stakeholders, focusing on creating a collaborative environment and intensive planning. Thus, the six steps for conducting the IPD pre-contract are presented (Ashcraft Jr., 2016); (Osburn et al., 2018) (Figure 4).

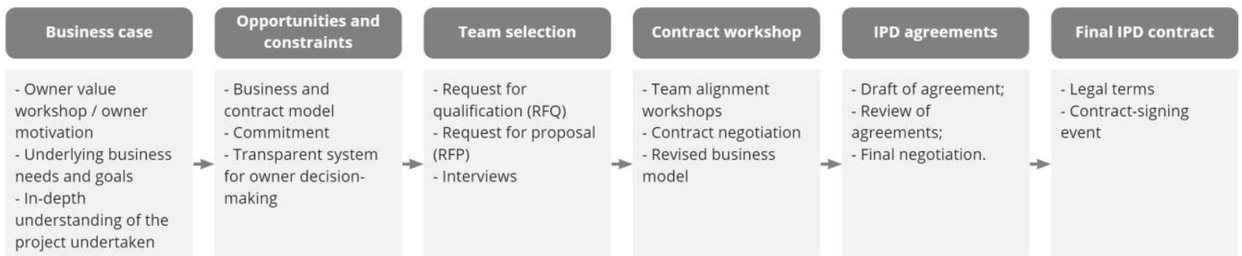

Figure 4. IPD path to pre-contract. Source: The authors, based on (Ashcraft Jr., 2016) and (Osburn et al., 2018).

The pre-contract is necessary to establish initial agreements and analyse the feasibility of applying the IPD among the parties previously involved, in a transition process. Pre-contract process is a mechanism in which participants with little, or no previous experience with IPD, can initiate a gradual paradigm shift (Osburn et al., 2018). In such a situation, the owner, who is the main decision-maker in the process, has the role of selecting the level of IPD collaboration to be applied to the project. Thus, the owner may choose to start applying the IPD gradually, from traditional delivery methods to a fully-fledged IPD contract.

Consequently, a business case should be developed at the beginning of the pre-contract stage as this is necessary to negotiate a suitable IPD agreement for the Project (Osburn et al., 2018). Furthermore, the business case is also necessary to support teams to join in collaborative work, to align project goals with commitment and to increase the likelihood of success (Ashcraft Jr., 2016). The pre-contract process for the readiness of stakeholders follows (Osburn et al., 2018); (Ashcraft Jr., 2016):

- *Business case - owners initiate the IPD process by adopting the catalysts, pre-existing relationships between parties, inviting key participants (architect/engineer/contractor) who have already had the opportunity of interacting in previous projects. The alignment of the business case promotes a full understanding of the project goals.*
- *Opportunity and constraint metrics - opportunity and constraint metrics are analysed and applied to evaluate the scope and interests, with commitment, and develop a transparent system for decision-making among parties. In the end, the main parties who decide to remain in the contract are structured to determine which teams should be in the IPD sharing system agreements.*
- *Team selection – the process is carried out through RFP (request for proposals) and RFQ (request for qualification). In this case, to include the other interested parties, the main participants can opt for informal selection, based on interviews, or for formal selection by qualification, or by submitting proposals (RFQ/RFP). The RFP process may be conducted by analysing documents, which cover the context of the project, and background information about IPD skills. In the RFQ, the procurement process is developed by evaluating financial and technical capacities, and the collaborative experience of the teams of participants.*
- *Contractual Workshop - the team representatives participate in a contractual workshop. In this process, teams are encouraged to establish collaborative work environments, applying the IPD principles during activities. Besides, a collaborative process is developed to make key decisions to be applied in the contract.*
- *IPD agreements - when all the above items are completed and revised, IPD agreements are presented for final negotiation.*

Final contract – this is signed between all parties to initiate the project production.

3. Research method

Design Science Research (DSR) is the methodological approach adopted in this investigation, in order to understand classes of problems and devise solution concepts for a specific field. Recent literature has pointed out that DSR is a rigorous research method, which emphasises the practical relevance of the investigation (Shrestha et al., 2018). DSR requires an in-depth understanding of a practical problem and an appropriate theoretical framework so that a solution can be devised, and the contributions can be made explicit (Dresch et al., 2015). There are different types of outcomes in DSR projects, such as models, methods, constructs, instantiations, and design theories (Dresch et al., 2015).

The artefact developed in this investigation is a model for gradual implementation of IPD, called IPDEM. This model consists of a set of design propositions for project delivery systems that describe the associations among constructs. Constructs can be described as conceptual elements, used to describe problems within a specific domain, and subsequently support the development of potential solutions for the classes of problems (Lacerda et al., 2013).

The literature provides guidelines for developing DSR projects (Shrestha et al., 2018). In fact, DSR is often divided into six phases, that were used to develop the present research, such as (Shrestha et al., 2018):

- *Relevant practical problem - the problem is defined and the importance of the solution (artefact) to be applied is justified.*
- *Definition of objectives and expected results - the theoretical solution is defined based on the practical problem.*
- *Artefact development - the type of artefact and functionality is determined so that the development is realistic.*
- *Demonstration – this demonstrates the effectiveness of the artefact in solving the problem.*
- *Evaluation - the effectiveness and efficiency of the artefact concerning its compatibility with the solution of the problem is observed.*
- *Diffusion - appropriate means are selected to disclose the artefact.*

Thus, for our research, we define DSR through:

- *Relevant problem: how can a transition be made from traditional to collaborative, relational construction project environments, to overcome the barriers and challenges for IPD application?*
- *Definition of objectives and expected results: propose IPDEM and implementation guidelines for the transition from traditional construction project delivery models to a full-fledged IPD implementations in construction projects.*
- *Artefact development: a IPD model were defined as a research artefact. The model is defined as a set of propositions or statements that express the relationships between the constructs.*
- *Demonstration and evaluation: the IPD model were developed, present and evaluated through a Focus Group.*
- *Diffusion: The artefact is being published in academic means.*

3.1.1 Research design

The development of the artefact was divided into three cycles. Each cycle consists of understanding the problem, a loop of development and analysis and the production of results (Figure 5).

The cycles were conducted with a Focus Group (FG). The FG is a group of participants with expertise in the topic analysed. The main role of the FG is to expose perceptions about the artefact. Thus, FG may be formed by groups of participants who work in a specific subject (Tremblay et al. 2010). The FG consider an effective number that varies from 6 to 12 people (Dias, 2000). For better effectiveness of the FG, the number of cycles and participants may be estimated, to promote an easy consensus process. Thus, less participants are more required to facilitate the consensus process (Stewart and Shamdasani, 1990).

The FG involved the participation of researchers, authors, and managers. Two researcher (authors), two researchers and three managers of construction companies, who had expertise in collaborative delivery methods and different project arrangements, were initially selected to participate in the FG (Table 1).

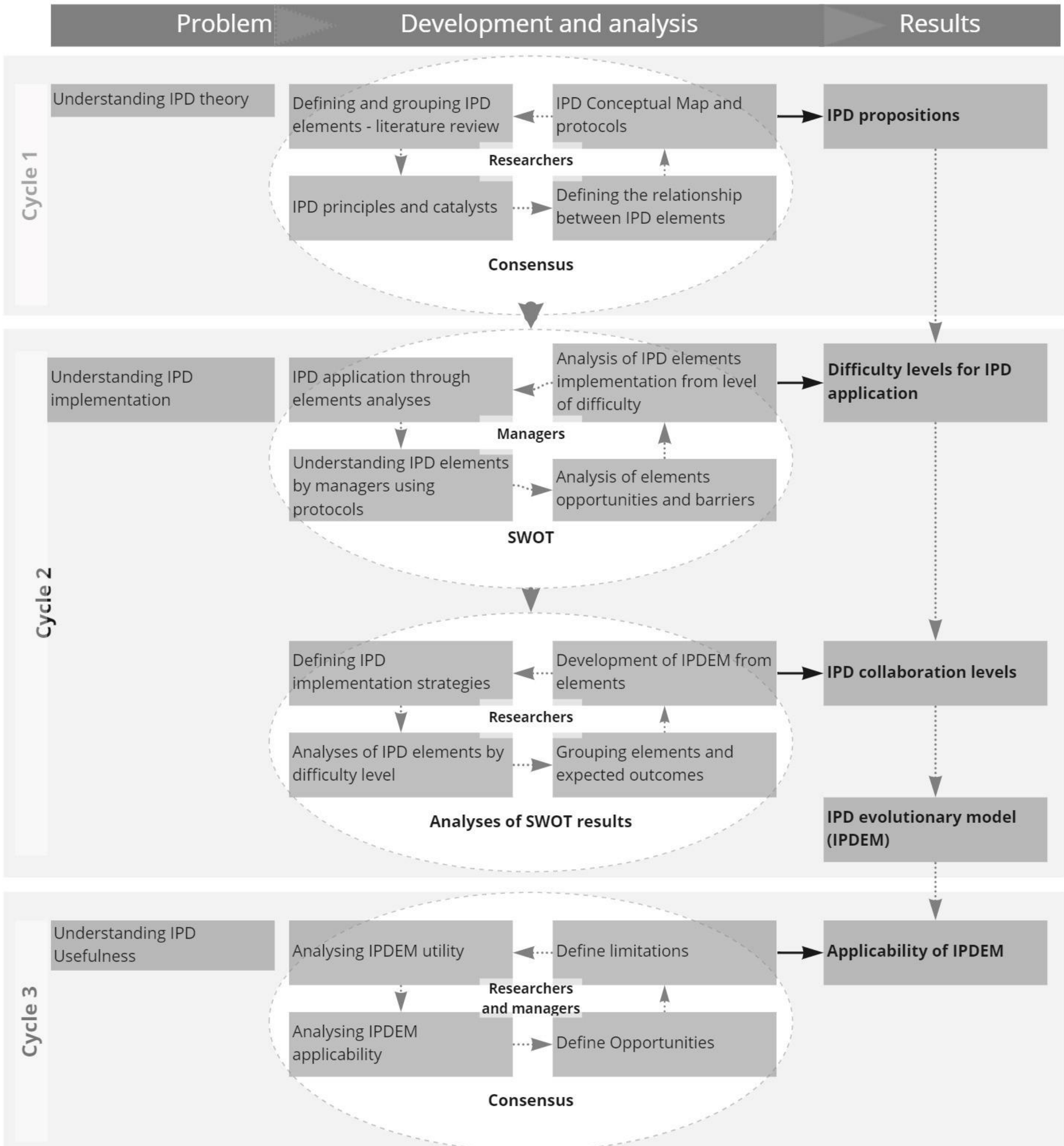

Figure 5. Research design. Source: The Authors.

Table 1. Focus Group participants.

	Participants – FG	Characterization
Researchers	Academic Researcher 1	Associate Professor at a University in USA. Specialised in construction management and project-based production systems. Develops research on IPD and lean production/construction concepts, also collaborates with construction companies towards the dissemination and implementation of lean.
	Academic Researcher 2	Full Professor at a University in Brazil. The researcher has more than 22 years of experience in the Administration field, focusing on production administration, civil construction, lean construction, production strategy, business strategy, and small companies.
Managers	Project Manager 1	Manager in a construction company that develops private and public projects, mostly based on DBB. The manager has more than 20 years of experience in project management.
	Project Manager 2	Manager in a construction company that develops projects in subcontracted systems. Works on both public and private projects. Has experience with the DB and DBB contract regime. The manager has more than 15 years of experience in project management.
	Project Manager 3	Manager in a construction company that develops mostly public projects, based on DBB. The manager has more than 15 years of experience in project management.

Source: The Authors.

The FG interaction was developed throughout four months of research development using a virtual platform with two hours of meetings for each interaction. During the process, all discussions were transcribed for analysis.

Cycle 1: Relevant problem and definition of objectives and expected results

The first cycle consists of a learning process of IPD theoretical foundations. In the first phase, a relevant research question was formulated, based on gaps identified in the literature, namely: How can a transition be made from traditional to collaborative, relational project environments, to overcome the barriers and challenges for IPD application? Then, an interactive process was developed involving the authors of the study and other researchers (Table 1), who are experts and are knowledgeable about collaborative project management methods. The interaction process with the team of researchers made it possible to identify associations between the elements of the IPD (catalysts and principles) and its concepts. The interaction also aimed to develop a Conceptual Map, as a visual representation of concepts involved in IPD. The main results from cycle 1 are a protocol containing definitions of IPD elements and an initial set of propositions, as shown in Section 4.1.

Cycle 2: Artefact development and demonstration

A protocol containing IPD information related to the proposed model was summarized and previously shared with a group of managers, who took part in this investigation (Table 1). Then, an interactive process involving managers, researchers, and author (researchers), who played the role of moderators, was developed to explain and clarify queries about the IPD literature context, and to identify the level of understanding and explanation of protocol content. A SWOT process was applied to analyse opportunities and barriers for the implementation of IPD elements. SWOT stands for strengths (S), weaknesses (W), opportunities (O), and threats (T). It is a technique generally adopted to guide systematic discussions of a specific situation, aiming to develop strategies to guide the achievement of the desired goal (Wang, 1990; Li et al., 2018). The SWOT strategy aims to maximize strengths and opportunities and minimize weaknesses and threats (Li et al., 2018).

For the SWOT application, interviews may be developed to determine and group the S-W-O-T elements. Subsequently, the elements are combined into two variants that form four categories (Hosseini et al., 2017) called:

- *SO (strengths and opportunities) considering the most possible IPD elements to be applied;*
- *ST (strengths and threats) considering the potential of strengths regarding the threats;*

- *WO (weaknesses and opportunities) it is considered that the environment offers opportunities to overcome weaknesses;*
- *WT (weaknesses and threats) is considered the prior necessity to minimize existing weaknesses and threats, before implementing the action or strategy to achieve the main goal.*

The elements of the IPD were classified based on their level of difficulty to implement, according to the analysis of statements and practical insights by managers' team. The results of this analysis were later shared with the team of researchers (Figure 5).

After applying SWOT, a second interaction was carried out with member of the team of researchers. An exercise was proposed to analyse the possibilities and difficulties of applying IPD elements. IPD elements were distributed within different collaboration levels to build up an evolutionary process for the gradual implementation of IPD. Four IPD levels were presented, consisting of difficult and moderate to apply elements. The IPDEM constitutes the main result of cycle 2.

Cycle 3: Evaluation - Applicability

After this process, the second interaction with the team of researchers and team of managers was carried out to analyse its applicability and to increase the possibilities of developing strategies to use IPD in existent contexts. In this process, opportunities and barriers were assessed to develop strategies for the applicability of IPD. The researchers and managers evaluated the model according to the possibilities of IPD implementation in projects in which they participate and interact professionally.

4. Discussion and results

4.1. Cycle 1 – Understanding the IPD theory

The first step to develop the conceptual map (Figure 6) was to create associations between concepts (Muianga et al., 2021). During the interaction with researchers (FG), IPD elements were classified according to the domains of a project management model, which are: organizational, commercial (contractual), and operational (Darrington et al., 2009). Systematically, the IPD aims to overcome problems related to organizational and contractual issues and is little focused on operational issues. (Darrington et al., 2009). Following the development of the association between the principles and their definition (as shown in (Figure 6)), the elements were divided into three categories:

- *Elements with a conceptual and contractual domain;*
- *Elements with an operational domain;*
- *Elements with organisational and management domains.*

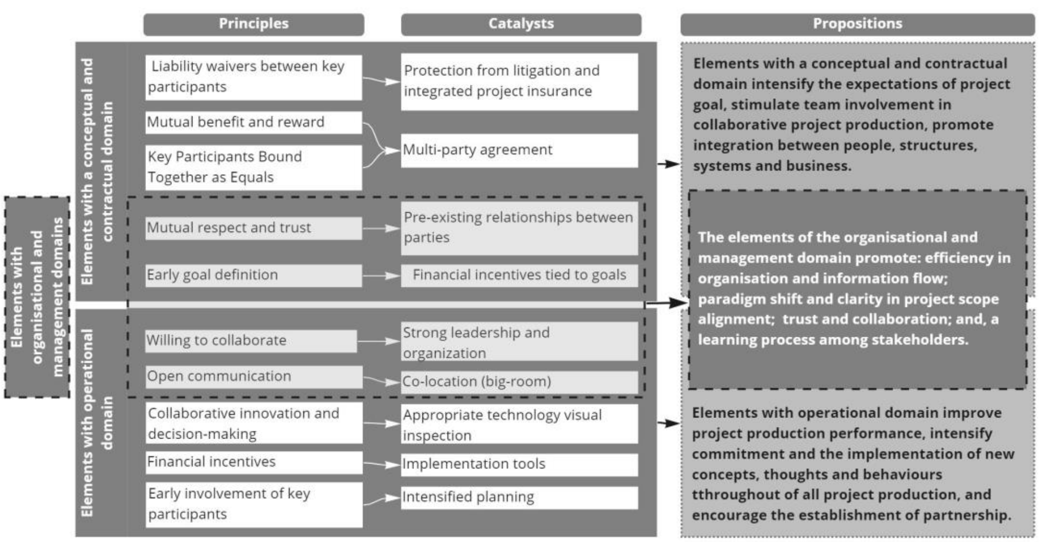

Figure 6. Conceptual Map of IPD elements. Source: The authors

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As a result, the relevant information from a group of IPD elements was used to formulate propositions. Those propositions correspond to the benefits which would be achieved with the effectiveness of both principles and catalysts.

Principles and catalysts with contractual domain may heighten expectations about project goals and stimulate interaction and performance among the parties engaged in the production. The organizational and management domain's principles and catalysts promote behaviour and open communication, resulting in benefits for fostering stakeholder trust. In addition, the operational domain's principles and catalysts may increase stakeholder commitment and drive continuous improvement, both in project management and paradigm shifts. The propositions presented combine information which could be used as performance parameters in construction projects when the principles are applied.

4.2. Cycle 2 – Understanding IPD implementation

The IPD elements were evaluated based on the practical experiences of construction project managers. Figure 7 shows the statements about IPD that were gathered and analysed during the interviews with the managers.

	*Principle **Catalysts involved	Statements of managers	Evaluation of applicability
S - strengths	*Early involvement of key participants	Private owners have a significant advantage in terms of early stakeholder selection and involvement. Moreover, owners may be able to select key participants using the "best value selection".	Moderately difficult to apply
O - opportunities	*Collaborative innovation and decision-making	The organization structure is hierarchical, and owners make major decisions. However, key participants have significant participation in project decisions – classified as moderately difficult to apply.	Moderately difficult to apply
	*Willing to collaborate and *Open communication	Communication flow when the "organization structure and "willingness to collaborate" are effective.	Moderately difficult to apply
	**Strong leadership and organization	Due to the autonomy to select the delivery method, private owners have a significant opportunity to apply IPD.	Moderately difficult to apply
W - weaknesses	*Early goal definition	Defining early goals through financial incentives is not feasible for the usual bidding process (based on DBB).	Highly difficult to apply
	**Pre-existing relationships between parties	The involvement of parties who had worked together at early stages might be applied if the owners decided to apply this concept.	Highly difficult to apply
	**Financial incentives	There is a need for significant paradigm changes and for setting up an incentive system to better align the goals and project value – classified as highly difficult to apply.	Highly difficult to apply
	*Mutual respect and trust	There might be a chance of establishing respect and trust if project benefits and goals were well-known.	Highly difficult to apply
	**Appropriate technology visual inspection	The implementation of unified technological systems may require a longer period for the parties to acquire knowledge and experience to adopt them effectively.	Highly difficult to apply
	**Co-location (big-room)	Co-location requires availability and implies additional costs to be fully implemented. However, in a usual construction process, all parties are allowed to work at the same location, using the same or separate rooms.	Highly difficult to apply
	**Intensified planning	Intensified planning requires overarching participation of stakeholders in the early stages. This involvement of all parties requires major changes in project contracts and an adequate delivery model.	Highly difficult to apply
T- threats	*Mutual benefit and reward *Liability waivers between key participants **Multi-party agreement **Protection from litigation and integrated project insurance	Organisations commonly manage risks and benefits on their own. The effective implementation of a relational contract requires training in knowledge of the process and its benefits to create more adherence to the integrated process and promote its diffusion.	Highly difficult to apply

Figure 7. Classification of IPD elements - SWOT. Source: The Authors

The matrix (Figure 8) was built based on the SO, ST, WO, and WT combinations from (Figure 7). This assessment points out the most favourable combinations that might promote and reduce unfavourable combinations for implementing the IPD.

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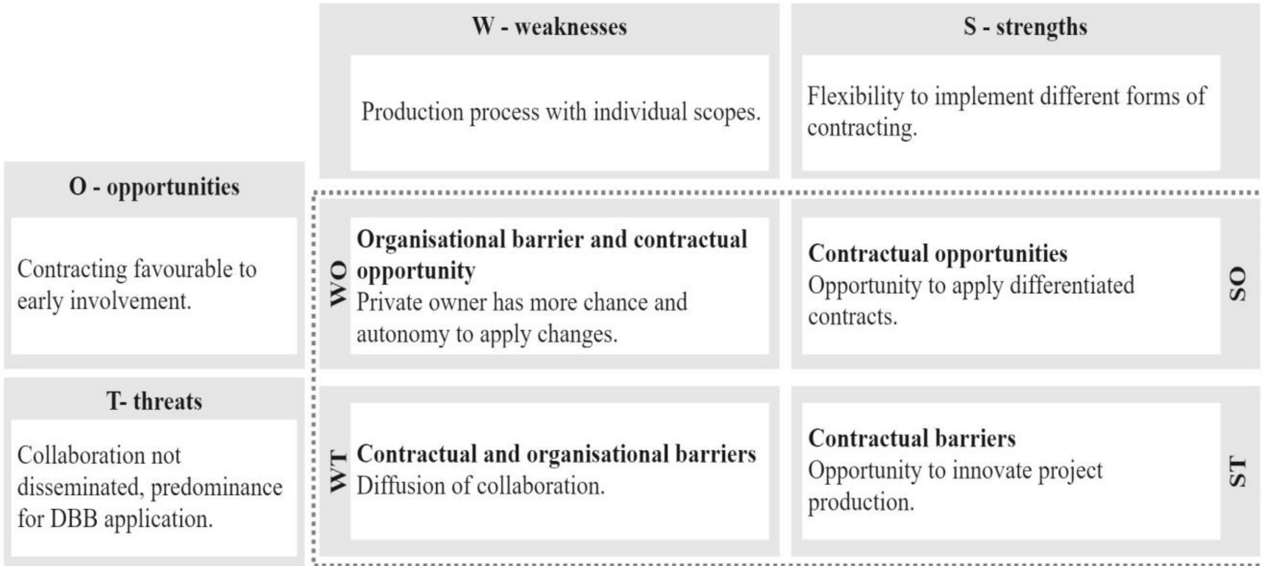

Figure 8. SWOT matrix. Source: The authors

Strengths - S, Weaknesses - W, Opportunities - O, Threats – T

According to (Figure 7) and (Figure 8), "WO" represents the organization's weaknesses in terms of recurrent individual scopes during the production process. Nevertheless, private owners have the ability and flexibility to implement IPD principles, such as early involvement of stakeholders. The threats are primarily contractual constraints, and "WT" is associated with little collaboration diffusion.

Organisational and operational issues influence "SO". The possibility of applying contracts established under the law is a strength, and may support the early involvement of principal participants (contractor and designers). However, "ST" the threats related to contractual burdens are reflected due to the predominance of DBB application, which limits the implementation and application of flexible and collaborative contractual models.

An interaction with researchers was carried out to synthesize (Figure 7) and (Figure 8), to classify the IPD elements into collaboration levels. In (Figure 7), IPD elements were evaluated according to the level of applicability (Figure 9). Two categories of IPD elements emerged from the focus groups, considering the degree of difficulty to implement: moderate, and highly difficult.

(Figure 10) presents the distribution of elements in different collaboration levels. Thus, the elements were structured for each collaboration level of IPDEM, based on the IPD level of collaboration and required or desirable elements (Figure 1) and (Figure 3) and (Figure 9). Thus, following (Figure 10), and based on the classification presented in (Figure 3), the desirable elements with a moderately difficult level comprised Collaboration level 1, and "other desirable elements", but on a higher difficulty level, they were structured for Collaboration level 2. The other elements classified as highly difficult and not considered in IPD-ish were applied at Collaboration level 3.

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For pre-contract	*Principle **Catalysts involved	Evaluation of applicability	SWOT
Opportunities and constraints	**Strong leadership and organization	**Moderate	**O
Team selection	*Early involvement of key participants	*Moderate	*S
	**Intensified planning	**High	**T
Contract workshop	*Collaborative innovation and decision-making	*Moderate	*O
	**Appropriate technology visual inspection	**High	**W
Value alignment	*Early goal definition	*High	*W
	**Financial incentives	**High	**W
	*Mutual respect and trust	*High	*W
	**Pre-existing relationships between parties	**High	**W
Revised business model	*Open communication	*Moderate	*O
	*Willing to collaborate	*Moderate	*O
	**Co-location (big-room)	**High	**W
Draft IPD agreements	*Mutual benefit and reward	*High	*T
	*Liability waivers between key participants	**High	**T
	**Multi-party agreement	*High	*T
	**Protection from litigation and integrated project insurance	**High	**T

Figure 9. Proposition of distribution of elements at different collaboration levels, Source: The authors. SWOT - Strengths - S, Weaknesses - W, Opportunities - O, Threats – T

For pre-contract	*Principle **Catalysts involved	Evaluation of applicability	SWOT
Opportunities and constraints	**Strong leadership and organization	**Moderate	**O
Team selection	*Early involvement of key participants	*Moderate	*S
	**Intensified planning	**High	**T
Contract workshop	*Collaborative innovation and decision-making	*Moderate	*O
	**Appropriate technology visual inspection	**High	**W
Value alignment	*Early goal definition	*High	*W
	**Financial incentives	**High	**W
	*Mutual respect and trust	*High	*W
	**Pre-existing relationships between parties	**High	**W
Revised business model	*Open communication	*Moderate	*O
	*Willing to collaborate	*Moderate	*O
	**Co-location (big-room)	**High	**W
Draft IPD agreements	*Mutual benefit and reward	*High	*T
	*Liability waivers between key participants	**High	**T
	**Multi-party agreement	*High	*T
	**Protection from litigation and integrated project insurance	**High	**T

Figure 10. Distribution of IPD elements at different collaboration levels. Source: The authors.

The IPDEM implementation model (Figure 11) defines the sequence for gradually implementing IPD elements, showing procedures for applying the model. Three collaboration levels were considered in the development of

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IPDEM, along with the pre-contract to be applied at the beginning of the process. Collaboration level 1 is based on the desirable elements for IPD-ish (Figure 3) and classified as moderate to be applied (Figure 9), and (Figure 10). Based on the desirable elements (Figure 3), on levels 1 and 2 of IPD-ish, some of those elements were classified with a high level of difficulty to be implemented such as "co-location, intensified planning, and the use of appropriate technologies' ', also desirable. For this reason, they were classified to be applied at level 2 of collaboration (Figure 10). At collaboration level 3 (pure IPD), the required elements of IPD (Figure 3) were presented in (Figure 10). It should be noteworthy that these elements are not considered in the IPD-ish, as they are ranked at a high level of difficulty (Figure 10). Thus, the model shows the evolution from the business case pre-contract phase to the highest level of IPD, together with the elements that can be applied in each of the required collaboration levels.

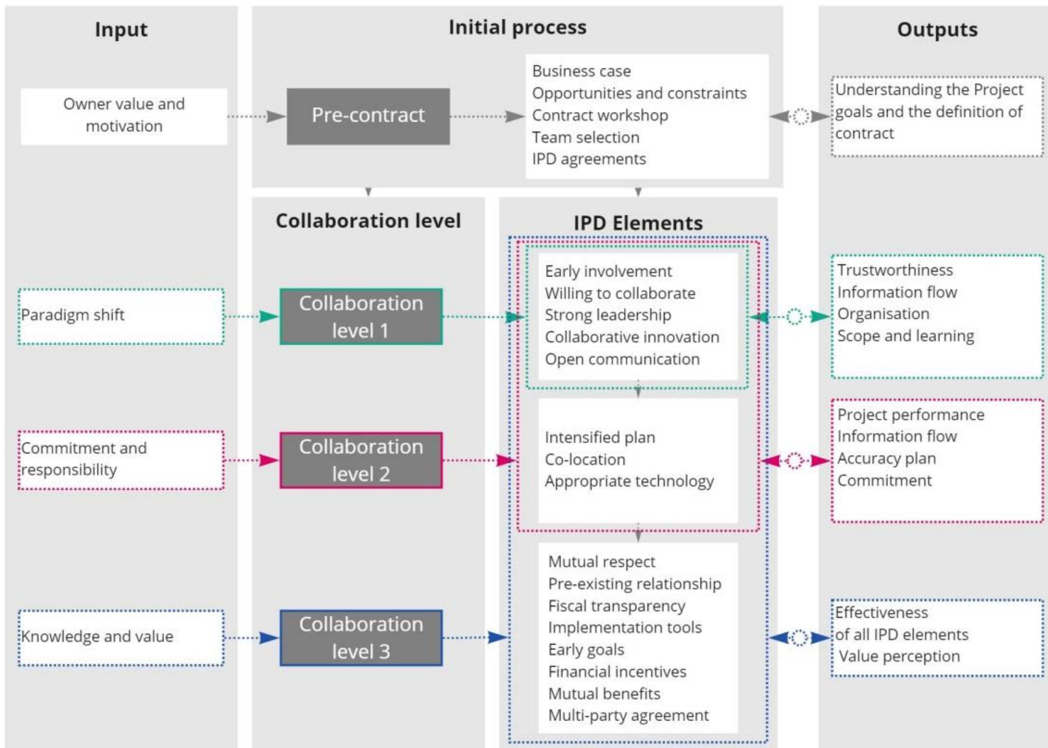

Figure 11. IPDEM implementation. Source: The authors.

Pre-contract: the first step of the IPD pre-contract is related to the dissemination, learning, knowledge, and evaluation of the requirements to perform the project. In this phase, the alignment and full understanding of the project is expected in terms of goals, scope and stakeholder's interests, selection of stakeholders through final negotiation and contract (presented in Section 1.3), establishing collaborative work environments, main decision-making, the definition of IPD agreements, and the final contract.

Collaboration level 1: applying level 1 of collaboration after the pre-contract process in environments when the IPD is not well known yet, this action can facilitate the application of the main elements that make up this level of collaboration. In this case, it is considered that there is already a typical collaboration (key decisions established regarding the scope and goals of the project) among parties. From a strong leader (owner, or one of the participants of the core group, architect/engineer/contractor), teams are expected to collaborate and be committed to open communication from the early stage of the project. The IPD elements presented at the first level are connected to a cohesive process and may increase the paradigm shift to achieve the first benefits of IPD, such as trustworthiness, improved communication flow and organizational structure, clarity of scope, and learning.

Collaboration level 2: for this reason, they were classified to be applied at level 2 of collaboration (Figure 10), (Figure 11). It is considered that the elements are more likely to be effective if all parties had previous experience in *collaborative production environments or already have the desirable skills of level 1. The co-location element may intensify open communication, and lead to more assertive planning. In addition, there are opportunities to apply appropriate technologies which contribute to more accurate planning and communication flow. The benefits for level 2 include information accuracy, commitment, and continuous improvement. Having an effective performance of levels 1 and 2, parties might be encouraged to step forward with more confidence to the highest level 3.*

Collaboration level 3: the elements of level 3 require knowledge and experience with the IPD to be effective. For instance, at this level, the multi-party agreement is essential for teams to be committed to the contract. The main benefit of level 3 is the effectiveness of all IPD elements and the perception of the model value. The application of different levels of collaboration (Figure 10), (Figure 11) is independent of each other. However, for the major IPD benefits, it is considered that significant elements of the preceding levels are already being implemented to ensure the effectiveness of IPD at the level applied. In this regard, the literature points out the possibility for participants to decide the suitable IPD alternative (IPD level 1 or IPD level 2) to start, aligned with the owner's culture and willingness to embrace change, and move gradually to the highest level (IPD level 3). Thus, it is considered that before applying a certain level of collaboration, it is necessary to analyse whether there are capabilities to apply elements for the IPDEM (collaboration level) selected. The period to transit from a previous level to the next is inherent in knowledge, experience, and necessary readiness.

4.3. Cycle 3 – Assessing IPDEM applicability

In IPDEM implementation, pre-contract (Figure 11) is considered the phase for the learning in order to achieve readiness for IPD application. The IPDEM also presents evolutionary stages of collaboration (collaboration levels 1, 2 and 3) that include the cumulative inclusion of IPD elements, as a means of transitioning from a less collaborative environment to a relational contracting. (Table 2) presents the utility and applicability of the model.

Table 2. IPDEM, utility, and applicability. Source: The authors

IPDEM utility	*Description*
IPDEM Diffusion	*Stimulating interest and knowledge to enable gradual application of IPD, and promote the diffusion of collaborative practices.*
Partial benefits of the model	*The hybrid and flexible IPD model may motivate the stakeholders of construction projects to adopt IPD in gradual steps.*
IPDEM applicability	
Pre-contract process	*The model ensures the readiness of parties, by considering previous experience to observe minimal knowledge of the process and easiness to apply its elements.*
Planning efficiency	*The model promotes a pre-contract process which may intensify planning, construction process details and provide clear definition of goals.*
IPDEM	*The model can be applied as a mechanism of a gradual and evolutionary transition from traditional contracts to relational.*
Adaptable for different contexts of insertion	*The model substantiates its adaptability to varied conditions of construction projects, considering different levels of collaborative practices, or even initial stages of collaborative production.*
Flexibility	*The IPD model can be applied combined with the usual contracts and laws of different locations and contexts of insertion. The partial application of IPD, in a hybrid model, may allow more constrained project and construction environments to benefit from.*

From the literature, it was observed that catalysts have the functionality to enhance principles, and may or not be applied along with the principles. Moreover, it was observed that catalysts may differ from those proposed in the literature. The application of catalysts depends on the selection of appropriate mechanisms considered more suitable to achieve project goals, combined with the IPD principles involved in the adopted level of the IPDEM.

The IPDEM may be used to diffuse IPD in an evolutionary process, both in the academic and professional fields. Emphasising its principles and catalysts, the IPDEM may be combined with already existing management *models and enhance the possibilities of professionals and owners who are less experienced with collaborative environments to achieve readiness gradually, stimulating the learning process, eliminating contractual barriers, and promote the adaptability of IPD in the real project context. In addition, the need for early and collaborative decision-making, along with stimulating collaboration, can allow the definition of more concise and detailed goals.*

A feasibility study is important for incorporating improvements in the IPDEM. However, the proposed model can potentially contribute to the reduction of several of the problems faced in the production of current projects, and thus provide collaborative production environments focused on value delivery.

5. Conclusions

To answer how to transition from traditional to collaborative design environments, focusing on the adoption of IPD, we selected Design Science Research as a research strategy. Analysing the IPD literature resulted in a "conceptual map", which succinctly demonstrates how the principles and catalysts of the IPD are related, and highlights the results promoted by effectively applying the IPD elements while carrying out the projects.

Focus group exercises involving iterative cycles for developing and evaluating the proposed IPDEM and strategies for its broader application in construction projects with little diffusion of collaborative practices were pointed out. The IPDEM guides the transition process from traditional, non-collaborative project delivery models to collaborative and integrated ones.

Nonetheless, significant factors may dissuade IPD's broader adoption, such as cultural barriers, legal and contractual restrictions, low technological and organizational expertise. So far, little attention has been addressed on how to overcome the barriers of IPD implementation in AEC environments, where collaboration between stakeholders is frequently poor or even absent. Despite the challenges of a full-fledged IPD use overall, the IPDEM is sufficiently flexible for a gradual implementation strategy. This approach allows the adoption of IPD with appropriate strategies to the specific particularities of projects, in terms of required collaboration levels and different regional scenarios or cultures.

The IPDEM was developed from empirical studies with the participation of FG. However, its development in practical and current project production contexts was not addressed. Thus, the definition of the model from the non-real context may not guarantee its full applicability. Thus, a feasibility study is important to incorporate improvements in the IPDEM. There is a need to demonstrate the applicability of the model from a more comprehensive assessment.

However, the applied methodological approach allowed the understanding of IPD flexibility. In this context, it was found that the evolutionary model may solve problems related to the paradigm shift and the introduction of innovative concepts in AEC in a gradual environment.

In conclusion, the research contributes to an understanding of IPD and its constituents. We synthesise those needs into its guiding elements, principles, and catalysts and offer an IPDEM as an alternative to overcome the challenging conditions for IPD use in the construction industry. Finally, understanding the process of transition from traditional project delivery to collaborative and relational models, such as IPD provide opportunities for their broader adoption in AEC.

For forthcoming research, it is expected to develop the analysis of the IPDEM simultaneously applying parameterized instruments to assess all levels of IPD collaboration proposed in this study. Those analyses may allow the extrapolation and applicability of IPDEM in different scenarios and contexts as a means to attain a major contribution of the applicability of the proposed model.

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6. References

AIA. (2007). Integrated Project Delivery: A Guide. AIA California Council.

AIA, NASFA, COAA, APPA, AGC. (2010). Integrated project delivery - IPD for Public and Private Owners: A joint effort of NASFA, COAA, APPA. Lexington, KY, 40.

AIA. (2012). IPD Case Studies. School of Architecture University of Minnesota.

Alinezhad, M., Saghatforoush, E., Kahvandi, Z., Preece, C. (2020). Analysis of the benefits of implementation of IPD for construction project stakeholders. Civil Engineering Journal, 6(8): 1609–1621.

Ashcraft Jr. H. W. (2014). The Transformation of Project Delivery. The Construction Lawyer, 34(4): 35-58.

Ashcraft Jr., H. W. (2016). Negotiation is the First Collaborative Act. IPD / BIM. Hanson Bridgett.

Azhar, N.; Kang, Y.; Ahmad, I. U. (2014). "Factors Influencing Integrated Project Delivery in Publicly Owned Construction Projects: An Information Modelling Perspective" Procedia Engineering, Fourth International Symposium on Infrastructure Engineering in Developing Countries, IEDC 2013. 77: 213–221.

Ballard, G. (2012). Should Project Budgets be Based on Worth or Cost? In: Proceedings For The 20th Annual Conference Of The International Group For Lean Construction. San Diego: IGLC.

Darrington, J., Dunne, D., Lichtig, W. (2009). Organization, Operating System, and Commercial Terms. Managing Integrated Project Delivery, CMAA, McLean, Virginia, 10-47.

Dresch, A., Lacerda, D. P., Júnior, J. A. V. A. (2015). Design Science Research: a method for science and technology advancement. Switzerland: Springer.

Dias C. A. (2000). Grupo Focal: técnica de coleta de dados em pesquisas qualitativas. Revista informação sociedade, 10(2).

Durdyev, S. et al. (2019). Barriers to the use of integrated project delivery (IPD): a quantified model for Malaysia. Engineering, Construction, and Architectural Management. Emerald Group Publishing Ltd., 27(1):186–204.

Elghaish, F., Abrishami, S., Hosseini, M.R. and Abu-Samra, S. (2021). Revolutionising cost structure for integrated project delivery: a BIM-based solution. Engineering, Construction, and Architectural Management, 28(4): 1214-1240.

Engebø, A., Lædre, O., Young, B., Larssen, P. F., Lohne, J., and Klakegg, O. J. (2020). Collaborative project delivery methods: A scoping review. Journal of Civil Engineering and Management, 26(3), 278–303.

Evans, M., Farrell, P., Elbeltagi, E., Dion, H. (2021). Competency framework to integrate lean construction and integrated project delivery on construction megaprojects: towards a future of work global initiatives in multinational engineering organisations. Benchmarking: An International Journal, 29(6): 1913-1956.

Hall, D. M., and Scott, W. R. (2019). Early Stages in the Institutionalization of Integrated Project Delivery. Project Management Journal, 50(2): 128–143.

Hamzeh, F. et al. (2019). Integrated project delivery as an enabler for collaboration: a Middle East perspective. Built Environment Project and Asset Management. Emerald Group Publishing Ltd., 9(3): 334–347.

Hellmund, A. J.; Van Den Wymelenberg, K. G.; Baker, K. (2008). Facing the challenges of integrated design and project delivery. In: 26TH West Coast Energy Management Congress 2008, 23–27.

Hosseini, A.; Pourahmad, A.; Taeeb, A.; Amini, M.; Behvandi, S. (2017). Renewal strategies and neighborhood participation on urban blight. International Journal of Sustainable Built Environment, 6(1): 113–121.

Hosseini, M.R., Banihashemi, S., Martek, I., Golizadeh, H. and Ghodoosi, F. (2018). Sustainable delivery of megaprojects in Iran: integrated model of contextual factors. Journal of Management in Engineering, 34(2): 1-12.

Jadidoleslami, S. et al. (2019). A practical framework to facilitate constructability implementation using the integrated project delivery approach: a case study. International Journal of Construction Management, 5.

Kahvandi, Z., Saghatforoush, E., Ravasan, A.Z., Viana, M.L. (2020). A Review and Classification of Integrated Project Delivery Implementation Enablers. Journal of Construction in Developing Countries, 25(2): 219–236.

Kahvandi, Z., Saghatforoush, E., ZareRavasan, A., Preece, C. (2019). Integrated Project Delivery Implementation Challenges in the Construction Industry, Civil Engineering Journal, 5(8): 1672–1683.

Koskela, L.; Ballard, G. (2006). Should project management be based on theories of economics or production? Building Research and Information, 34(2): 154–163.

Kristensen, K.; Lædre, O.; Svalestuen, F.; Lohne, J. (2015). Contract Models and Compensation Formats in the Design Process. In: 23rd Annual Conference of the International Group for Lean Construction, 599–608.

Lacerda, D. P. et al. (2013). Design Science Research: a research method to production engineering. Gestão and Produção, 20(4): 741–761.

Liu, G., Zheng, S., Xu, P., Zhuang, T. (2018). An ANP-SWOT approach for ESCOs industry strategies in Chinese building sectors. Renewable and Sustainable Energy Reviews, 93: 90–99.

Lee, H. W., Anderson, S. M., Kim, Y-W., Ballard, G. (2014). Advancing impact of education, training, and professional experience on integrated project delivery. Practice Periodical on Structural Design and Construction, 19(1): 8–14.

Leicht, R. M., Molenaar, K. R., Messner, J. I., Franz, B. W., Esmaeili, B. (2016). Maximizing Success in Integrated Projects: An Owner's Guide. 1. The Pennsylvania State University.

Li, S., Ma, Q. (2017). Barriers and challenges to implement integrated project delivery in China. In: IGLC 2017 - Proceedings of the 25th Annual Conference of the International Group for Lean Construction. The International Group for Lean Construction, 341–348.

Mesa, H. A., Molenaar, K. R., Alarcón, L. F. (2016). Exploring performance of the integrated project delivery process on complex building projects. International Journal of Project Management, 34(7): 1089–1101.

Matthews, O.; Howell, G. (2005). Integrated Project Delivery: An Example of Relational Contracting. Lean Construction Journal, 2: 46–61.

Mollaoglu-Korkmaz, S., Miller, V. D., Sun, W. (2014). Assessing key dimensions to effective innovation implementation in interorganizational project teams: An Integrated Project Delivery case. The Engineering Project Organization Journal, 4(1): 17-30.

Moylan, W. A.; Arafah, N. (2017). Integrated Project Delivery: Complicated Collaboration or Improbable Panacea. PM World Journal, 6(7).

Muianga, E. A. D. (2019). Evolutionary model for IPD implementation in construction projects with little diffusion of collaborative practices. Thesis. Universidade Estadual de Campinas, Faculdade de Engenharia Civil, Arquitetura e Urbanismo, Campinas, SP. 251p. 2019

Muianga, E. A. D.; Granja, A. D. (2021). Estrutura conceitual do integrated project delivery (IPD): princípios, catalisadores e proposições. Gestão & Tecnologia de Projetos, 16(2), 173–195.

Osburn et al. (2018). Integrated project delivery: An Action Guide for Leaders. Charles Pankow Foundation.

Park, J.; Kwak, Y. H. (2017). Design-Bid-Build (DBB) vs. Design-Build (DB) in the U.S. public transportation projects: The choice and consequences. International Journal of Project Management, 35(3): 280–295.

Shrestha, A., Cater-Steela, A., Tolemana, M., Rout, T. (2018). Benefits and relevance of International Standards in a design science research project for process assessments. Computer Standards and Interfaces, 60: 48–56.

Sive, T. (2009). Integrated Project Delivery: Reality and Promise. A Strategist's Guide to Understanding and Marketing IPD. Marketing Research, SMPS Foundation.

Stewart, D. W.; Shamdasani, P. N. (1990) Focus Groups: Theory and Practice. SAGE Publications, 1990.

Tremblay, M.; Hevner, A.; Berndt, D. (2010). Focus Groups for Artefact Refinement and Evaluation in Design Research. Communications of the Association for Information Systems, 26(1).

Thomsen, C., Darrington, J., Dunne, D., And Lichtig, W. (2009) Managing integrated project delivery. Construction Management Association of America (CMAA), McLean, Virginia.

Verheij, H., Augenbroe, G. (2006). Collaborative planning of AEC projects and partnerships. Automation in Construction, 15(4): 428–437.

Wang, P. (1990). Strategic analysis and choice: How Direct Marketers Can Succeed in the 1990s. Journal of Direct Marketing, 6(2): 40–50.

Whang, S. W., Park, K. S. and Kim, S. (2019). Critical success factors for implementing integrated construction project delivery. Engineering, Construction and Architectural Management. Emerald Group Publishing Ltd., 26(10): 2432–2446.

Zhang, Y. and Hu, H. (2018). Utilization of a cognitive task analysis for integrated project delivery application: Case study of constructing a campus underground parking facility. Cognitive Systems Research. Elsevier B. 52: 579–590.