Conceptual Framework for Implementing Integrated Project Delivery for Infrastructure Projects in Peru.

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CONCEPTUAL FRAMEWORK FOR IMPLEMENTING INTEGRATED PROJECT DELIVERY IN INFRASTRUCTURE PROJECTS IN PERU

by

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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science in Civil Engineering

Department of Civil Engineering
West Lafayette, Indiana
August 2018
THE PURDUE UNIVERSITY GRADUATE SCHOOL  
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To my mom, Julia Villanueva Chavez, whom I am eternally grateful to for being my biggest motivation, and my constant source of support, encouragement, and true love.

My little sister, Michelle, I cannot thank you enough for making me the proudest sister in the world for your kindness and pure soul. You have made me a better person.

My little brother, Cesar, who deeply believed in me and the fact that I belong at home and nowhere else. Thank you for being my kid and my guide. I do owe you a huge one.

My friend, Martin, very special thanks goes out to you for taking care of my family and me even from far away. I truly appreciate all your effort.

I want to sincerely express my very profound gratitude to Clara Cordova and Eloy Chavez for giving me a home in Indiana. I am very grateful to have found a wonderful family far away from home.

My coach, Dr. Mark Hastak, for setting such highest expectations, this work goes to you.

Thank you all for being a part of my life. You have enlightened my path in every sense. All I am is because of you.
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LIST OF ABBREVIATIONS

AIA: American Institute of Architects
IPD: Integrated Project Delivery
LCI: Lean Construction Institute
P2SL: Project Production Systems Laboratory
ABSTRACT

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Degree Received: August 2018
Title: Conceptual Framework for Implementing Integrated Project Delivery for Infrastructure Projects in Peru.
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Integrated project delivery (IPD) implies a transformational change of project participants’ behaviors and current practices. This change aims to break down the traditional silos of construction and improve collaboration, communication, and alignment between the different stakeholders in a project. Diverse implications of integration have been developed and applied in the project management literature. Therefore, there is a need to structure the industry’s approach towards integration and identify common characteristics among these diverse approaches. In this study, the author explored the blueprints of integration in the project management literature and identified common patterns across the theoretical foundations and case studies that have documented the processes and practices previously applied in real-world settings to propose a conceptual model that facilitates IPD implementation. For this purpose, the author performed a tertiary study of integration in the project management literature and then contrasted the findings with an inductive study of practice to identify current gaps between the Peruvian construction industry compared to the ideal state of an IPD project. Because the inductive and deductive coding process for the literature suggests that even though there is no consensus on the definition of IPD in the industry as a whole or what it involves, the objective of this study is to look deeply into the IPD literature by focusing on practical applications, identifying the principles and tools that have been applied, and detailing the approaches to behaviors that have governed IPD in practice thus far.

This study proposes a conceptual framework for IPD implementation that can be used to facilitate the transition from traditional approaches to an IPD system. The study is based on a tertiary analysis of the existing body of knowledge, a detailed survey of the current approach to construction projects, and an analysis of a case study involving the
implementation of IPD in Peru. The newly integrated approach in construction, IPD, supports the use of tools and principles that have previously been implemented in different ways within various organizations. The author explains in detail the principles and tools that facilitate IPD and presents a guide to practitioners concerning how to leverage the implementation of these tools and principles based on stakeholders’ expectations and behaviors. The conceptual framework proposed by the author serves as a guideline on how industry practitioners can better implement an IPD approach to improve the delivery of construction projects.

The proposed framework for implementing IPD plays an important role in understanding the principles that govern IPD and the available tools that can facilitate IPD implementation while accounting for the trade-offs that might potentially occur during the different stages of a project. Infrastructure projects are often highly complex, which emphasizes the need for integration, particularly in a new market such as Peru. Although some Lean construction and building information modeling (BIM) concepts are increasingly being adopted in Peru with support from the Lean Construction Institute in Peru (LCI Peru), there is still a lack of knowledge in the market regarding IPD as a delivery method and its corresponding tools and principles. By exploring and analyzing the contextual nuances of concept adaptation and any associated challenges in Peru and contrasting current practice with the theoretical framework on this topic, the author has also included suggestions to further improve the Peruvian construction industry in the next 15 year-period with the help and support of the Lean Construction Institute’s Peruvian chapter.
1. INTRODUCTION

1.1 Background

The architecture, engineering, and construction (AEC) industry has been characterized as a highly fragmented sector and this division often results in poor project performance in terms of productivity, safety, and quality (Mesa et al., 2016; Nawi et al., 2014a). Researchers such as Mills (2001), Aapaoja (2013), Zhang et al. (2013), Demirkesen and Ozorhon (2017) and Nawi et al. (2014a) have described the construction industry as being one of the most complex, dynamic, risky, fragmented, and challenging industries. The never-ending issue of having projects that often do not meet the owner’s performance requirements (Lichtig, 2006) can be attributed to reasons that the Construction Users Roundtable (2014) report suggested which announced that lack of cooperation and poor integration is one of the root causes for most cost and schedule overruns. In addition, Mitropoulos and Tatum (2000) found that the degree of project integration directly affects project performance outcomes.

Although construction projects might appear to be similar in scope, they are unique not only due to differences in scope but also because of surrounding contexts (Ghassemi and Becerik-Gerber, 2011; Pishdad-Bozorgi, 2017), and therefore projects are full of uncertainties (Liu, 2013). To reiterate, construction projects are often seen as complex (Franz et al., 2017; Do et al., 2015; Palacios et al., 2011). This is particularly true in the case of building infrastructure projects due to the numerous organizations working together on a given project and the collective relationships that are formed between individuals with different backgrounds, beliefs, and expectations. According to Wood and Gidado (2008), the process of designing, constructing, and operating facilities along with the interactions that occur between the stages is particularly complex. Such projects are also characterized by complex decision-making processes, multistakeholder involvement to deal with the high level of risk, and the uncertainty and ambiguity that comes with these additional considerations (Walker et al., 2016).

As a result, the owners of complex projects, general contractors, and architects are all exploring the use of collaborative practices to improve project performance (Khanzode et
al., 2005; Reed et al., 2006). In an integrated project, the contractor's knowledge of constructability and value engineering can add great value to the project during the design phase; however, contractors are traditionally seen mostly as builders only and thus are often assigned during the execution phase of the project (Heravi et al., 2015). Pishdad-Bozorgi (2017) indicated that the uniqueness and complexity of construction projects foster collaboration and integrated project delivery (IPD) has proven its effectiveness in managing complex, dynamic, and fast projects (Ballard et al., 2011; Bilbo et al., 2015). The Lean Construction Institute (LCI, 2017) introduced the following definition for IPD in its glossary:

“A delivery system that seeks to align interests, objectives and practices, by reconceiving the Organization, Operating System and Commercial Terms governing the project. The primary Team Members would include the Architect, key technical consultants as well as a general contractor and key specialty contractors. It creates an organization able to apply the principles and practices of the Lean Project Delivery System.”

Also, the American Institute of Architects (AIA, 2007) proposes a definition for IPD which entitles that IPD is:

“A project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.”

Moreover, Thomsen et al. (2010) have suggested that integrated project delivery (IPD) is a viable solution to current construction issues associated with traditional delivery systems. Dodge Data and Analytics (2016) developed a study that differentiated typical projects from the best ones in a sample of 162 projects, and the results show that the best projects choose IPD as the preferred method of project delivery over traditional approaches (see Fig. 1.1).

IPD aims to imply a transformational change in the behavior of the project participants and the means and methods they use. It aims to break down the traditional silos of construction and improve collaboration, communication, and alignment between different stakeholders.
in a project. Because infrastructure projects are often more complex than other projects, integration in project delivery is even more necessary. Even though integration might seem to be a natural requirement for success in multidisciplinary industries such as construction, resistance to change and negative attitudes towards new systems such as IPD remains prevalent mainly due to the lack of knowledge on and understanding of the subject or due to the lack of training on the topic (Fernandez-Solis et al., 2013).

The understanding and knowledge of IPD varies between organizations, projects, and potentially individual stakeholders. Some researchers firmly argue that IPD as an approach should be mandated by a contractual agreement (Cheng et al., 2016; Raisbeck et al., 2010; Korb et al., 2016; Miller et al., 2014; Daswani et al., 2015; El Asmar et al., 2013) with the expectation that contract clauses will change people and dictate how they will behave. However, culture and behavior cannot be legislated; therefore, contracts cannot change people’s behavior neither change the ingrained noncooperative environment that has been the status quo for years or traditional construction paradigms (Pishdad-Bozorgi and Beliveau, 2016b; Barker, 1993; Cheng et al., 2016; Ghassemi and Becerik-Gerber, 2011).
Others might categorize integrated projects as the ones that rely on the use of technology such as BIM or other modeling technologies. However, as Ashcraft (2008) said, BIM will only help to solve superficial problems if used without collaboration. In other words, the use of technology in a project does not define the level of integration that exists. In this context filled with many different definitions, most researchers agree on defining IPD as a spectrum of integrated approaches (Pishdad-Bozorgi and Beliveau, 2016b).

The above mentioned variation in the implications of IPD can be also observed in new markets were IPD just begin being implemented such Peru. While some Lean construction concepts are increasingly being adopted in Peru with support from Peru’s Lean Construction Institute, there is still a lack of knowledge in the market about IPD as a delivery method, its principles, and the tools to facilitate its implementation. Therefore, this study explores and analyzes construction practices in Peru and develops a conceptual framework that facilitates IPD implementation in three basic domains: i) the principles that shall govern an integrated project, ii) the tools that facilitate and sustain IPD in the project, and iii) the project governance structure that makes IPD more suitable for a given situation.

The author also explores the maturity of the construction industry in Peru, with particular emphasis on infrastructure projects due their high levels of complexity, and later identifies potential improvements by analyzing the results of an extensive survey conducted by LCI Peru. The author also deeply analyzes a case study that represents the first intentional application of IPD in Peru.

Infrastructure projects very often include the use of a completed facility (its operation and maintenance) as part of their scope; therefore, the entire life cycle of such infrastructure projects needs to be considered during project development and for the analysis of this study. This study aims to provide a conceptual framework for implementing IPD in construction projects throughout the different project phases, beginning from project definition all the way through to the use of a new facility. It also aims to address some of the main challenges that are presented in the current state of construction in Peru and add potential strategies that might assist in creating an integrated environment as part of the conceptual framework proposed for implementing IPD. These proposed steps include developing a sense of community and training participants in IPD related concepts, basic principles, means, and tools as well as incentivizing the participants’ willingness to change.
There have been plenty of research on IPD and there is a need to synthesize the body of knowledge to facilitate IPD implementation in new market such as Peru where IPD has never been applied. The author acknowledges certain limitations for IPD implementation such as current legislation in Peru that does not allow integrated agreements, but also evidence support that the lack of such agreements does not limit the implementation of integrated projects. As a consequence, a guideline that facilitates IPD implementation regardless of certain limitations is required.

1.2 Purpose and Research Scope

Regardless of the contractual agreement used in a project, construction projects themselves can be delivered through a variety of project delivery systems. The purpose of this study is to explore the research on integrated project delivery and its implications in practice through proposing a conceptual framework to facilitate its implementation based on IPD principles, the tools available to facilitate the process, and a governance structure that would facilitate the development an IPD project in Peru while considering the country’s cultural nuances and current practices. Particular emphasis will be put on infrastructure projects such as rail lines, highways, and medical facilities because they are characterized as being highly complex and it has been a common suggestion among practitioners and researchers that IPD can enhance project outcomes and improve stakeholder relationships due to its potential for dealing with complex projects.

1.3 Research Statement

IPD is a delivery system (i.e., a way project teams execute a given project) that has brought many improvements to the construction industry in terms of project performance, sustainability, work environment and the overall delivery of value to clients. Despite observed benefits in countries such as US, IPD has yet to be used in Peru. The thesis of this research is that successful implementation of IPD will enhance the delivery of infrastructure projects in Peru in terms of metrics such customer relations, safety, schedule, cost, quality, financial metrics, communication, and collaboration due to IPD’s potential for dealing with highly complex projects, specifically those that include the operation and
maintenance of a new structure in its scope. Its implementation includes various principles, tools, and a governance structure as described in the conceptual framework proposed in the research which facilitate users with a guide for systemic implementation of IPD.

1.4 Research Questions and Objectives

The central questions is: considering Peruvian cultural nuances and current practices in the construction industry, how can IPD implementation be facilitated successfully for infrastructure projects in Peru?

The following are the subquestions along with the objectives for each section:

1. What are the implications of integrated approach across the body of research? How can IPD be successfully implemented for complex construction projects (inductive)? – The objective here is to understand the principles that govern IPD, the tools that facilitate its implementation as a project delivery method, and the project governance structure that best promotes collaboration.

2. What are the expectations that motivate migrating to IPD and the enablers for acquiring collaborative behaviors suitable for IPD? – The objective here is to summarize the motivations and catalysts for change.

3. Is the current state of construction for infrastructure projects in Peru amenable to implementing IPD as a delivery method? – The objective here is to identify the gap between the ideal state of having integrated projects and the current state of practice in the Peruvian construction sector.

4. What changes are required in the next 15 years to make IPD projects feasible in Peru? – The objective here is to set a plan of action for improvement based on participants’ expectations and willingness to change.

1.5 Methodology

1.5.1 Research Design

The methodology employed in this study is divided into three main phases that are described in detail in this section (see Fig. 1.2) followed by a customization based on Peruvian construction industry main characteristics and proposed actions for improvement.
The author first starts by analyzing the existing body of knowledge regarding IPD by performing a systematic literature review and synthesizing key findings to develop a conceptual framework for IPD implementation. This first phase accounts for identifying key principles, tools, attitudes, and behaviors that foster IPD as a delivery method and facilitate its implementation. Second, since IPD has not been applied in the Peruvian market, but for only one company first trial, the author documented findings of a sample case study involving the construction of an infrastructure project in Peru in the form on IPD to highlight the gap between the practices used in that particular project and the practices supported by the proposed conceptual framework. As part of the case study, a questionnaire was developed along with LCI Peru academic committee to collect
information about current construction practices in the project under study. Questions such as “Which factors were considered in the project for choosing key partners?” and “What parties had been involved in the decision-making process?” were included. In the **third phase**, because IPD is relatively new in the Latin American construction industry, an extensive survey was conducted by LCI Peru which allows the author to better address IPD’s applicability in Peruvian construction culture. Such questionnaire aimed to analyze the efforts of current practitioners and their willingness to change. LCI sent out the surveys online using a virtual platform and the outcomes were analyzed by the author and presented to the academic committee for further discussion. The questionnaire was created based on an individual assessment questionnaire developed by the Lean Construction Institute (LCI). Respondents were asked to reflect on how much they identified with statements such as “We tend to have more side discussions about issues, than bring it to the group” or “I'm aware that my behavior influences the group.” By analyzing the state of the art concerning construction practices in Peru, the author identifies the gap between the conceptual framework proposed by the study and current practices.

Ultimately, the study includes the customization of the framework through feedback from advisors who are knowledgeable in IPD and Lean construction and gave suggestions for customizing IPD implementation framework based on Peruvian practices and limitations such as the legal barriers that limit the use of relational contracts or cultural barriers such as the current lack of trust governing the industry. In this phase, the author shared the conceptual framework with LCI Peru and the committee members for the study. LCI Peru provided feedback on the conceptual framework’s applicability and helped in defining a plan of action for improving the current state of construction for infrastructure projects in Peru. The author worked collaboratively with LCI Peru academic committee through monthly work sessions to develop a path forward for improvement. Construction industry in Peru changes very slow; however, the Peruvian government plan of investment in infrastructure projects accounts for a rapid investment in the next 10 years as it is published in a public report by a Peruvian government agency (Bonifaz et al., 2015). Moreover, the investment on infrastructure projects around the world is projected to double in the next 15 years (McKinsey & Company, 2015). The author develops a plan for improvement that stretches across the next 15 years, such plan considers that in the first 10 years the Peruvian
industry would catch up with IPD concept and mature the use of most of the concepts involved in such delivery system while the last 5 years are accounted for continuous improvement. Fig. 1.2 provides a summary of the study divided in the phases described above.

1.5.2 Research Method

The data collected has encompassed a mixture of both qualitative and quantitative data. The overall objective of the research is to figure out how to best implement IPD in the Peruvian construction industry for infrastructure projects, and to do that, the author analyzed and understood three things: First of all, how is it currently being used for those who apply it around the world, what is the state of practice and how to capture it, so the phase 1 of the study is developed to answer such inquires since it presents the analysis of the body of knowledge that has been documented and captured it by the systematic literature review. The outcome of phase 1 includes a conceptual framework that facilitate IPD implementation. Second, within Peru, there are two segments in the industry, one that understands lean and it is trying to use IPD and second people who have no clue about IPD as delivery system. If IPD were to be implemented by the entire construction industry, the population would need to understand first of all, how those who apply it are applying it, and second, those who have not applied it, what they would need to properly apply it. The author analyzed a case study with the first group, the ones with expertise in Lean and that were trying to use IPD, to better understand their perception and use of certain principles and tools of the framework proposed in the study. As part of the case study, a survey was designed based upon the information identified in the systematic literature review and constant feedback from experts on the subject was taken into account since the author received comments from advisors while developing the study to modify the content of the survey to answer specific questions regarding practices of the case study company. Later, a more general questionnaire is sent out through LCI Peru to the second group of participants who have never used IPD to understand their perception and current state of practice regarding lean and IPD concepts in the Peruvian industry in general. Based on the knowledge the author got from previous stages, the author revisited the framework to
understand if there was any customization needed based on specific constraints such as the legal barriers in Peruvian legislation.

Lastly, the author worked with the academic committee of LCI Peru to develop a path forward to improve. The plan of action for the next 15 years was then used to build upon the information collected from the survey responses and the proposed framework to explore areas of improvements and further analyze the framework’s applicability in a specific time period. All these different research approaches are described in detail in the following sections.

1.5.2.1 Systematic Literature Review (Phase 1)

A systematic analysis of the literature (SLR) addresses clear questions that had been previously formulated by the researcher and it uses systematic methods for identifying resources and analyzing the content of the body of knowledge to report valid and reliable results (O'Brien and Mc Guckin, 2016). Okoli and Schabram (2010) define SLR as “a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners.” In the first phase of the study, the author performed a tertiary analysis to review secondary sources on IPD (Kitchenham and Charters, 2007; Nurdiani et al., 2016; Arasteh et al., 2017; Opdyke et al., 2017) since: i) the topic of IPD has been researched extensively over the past decade, but ii) the existing studies of IPD remain fragmented and cover a wide range of practices and issues under the label of integration. Therefore, a systematic review of past literature illuminates the landscape of research on integration in the project management field. The analysis further aimed to outline the extent and context of current principles that are being applied when working with an IPD approach to classify and categorize existing practices and explore patterns across prior studies. The author created a database of journal papers, conference papers and articles were found through the internet and added other sources from practitioners and experts that were solicited and got them by email. Only documents written in English were considered in the analysis.

The search primarily started with “integrated project delivery” as the keyword in the Scopus database. This search resulted in 282 manuscripts, which were then complemented with the results found from searching the same term in five additional journals including
the *International Journal of Project Management*, *Journal of Management in Engineering*, *Project Management Journal*, *Journal of Construction Engineering and Management*, and *Construction Management and Economics*. This search increased the number of manuscripts to 430. In addition, 28 articles were added at the suggestion of Lean practitioners and industry experts who sent the papers by email at request of the author. The titles and abstracts of the 458 gathered manuscripts were then reviewed to remove any irrelevant or duplicated works. The criteria for the vetting process involved keeping papers that used integration for any formal or informal interactions between entities and thus took into account ideas such as collaboration, co-creation, and contractual involvement. The author examined each publication to decide whether it answered any of the study’s specific research questions. The majority of the 328 manuscripts removed were pulled due to lack of topic relevance; 103 works focused mainly on virtual reality or BIM coordination for interferences and prefabrication, 54 focused only on contractual agreements, 39 focused on educational purposes such as adding IPD as a subject to a school curriculum, 33 focused on sustainability and green building, and 30 focused on alliancing or partnering only. Moreover, 25 manuscripts were removed due to duplication, and 44 papers were pulled because they themselves were reviews or addressed other irrelevant topics. These latter topics included considerations of adding Lean and IPD courses to university curricula, supply chain optimization, and BIM as a modeling technique.

The resulting 130 manuscripts (Table 1.1) were imported to NVivo 12, which is a qualitative data analysis software for further coding and analysis (QSR International, 2018). A quality check was not performed at this stage because of the abundance of practitioner-based papers on the topic. The author used a combination of inductive and deductive coding strategies; inductive strategies include a detailed analysis of resources through close reading the materials while deductive coding start with specific words of themes and then explore them in the sources (Opdyke et al. 2017) to answer the four initial research inquiries: i) What is the extent of the use of the term “integration”? That is, what do the researchers mean when they use the term (inductive) (e.g., collaboration, alignment, etc.) ii) What are the common patterns in current practice that support IPD as a project delivery method? (deductive); iii) What has been explored in regard to shared governance (understanding a project governance structure, collaborative decision-making, and sharing risk and rewards)
when working in an integrated team? (inductive); and iv) What research has been done on attitudes, beliefs, expectations, and potential barriers concerning the application of an integrated approach (i.e., IPD)? (inductive). Inquiries one, three, and four used an inductive coding strategy while inquiry two used a deductive strategy. Nodes were created in NVivo based on these four research inquiries. Figure 1.3 shows the process followed to perform the systematic literature review of the existing body of knowledge.

![Figure 1.3 Systematic Literature Review Process](image)
In developing the coding process, parent and child nodes were created based on the author’s reasoning and in logical flow to answer the research questions. Content analysis was then performed at the elimination stage where the little and abstract of each paper was reviewed to exclude unrelated papers. A synthesis of the findings is presented in the next section. A total of 130 out of 458 papers were considered, representing 29% of the total number of documents gathered as a part of the study.

Table 1.1 Details of integrated project delivery articles identified in the research study

<table>
<thead>
<tr>
<th>Source</th>
<th>Initial sample</th>
<th>Articles removed</th>
<th>Final sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus</td>
<td>282</td>
<td>196</td>
<td>86</td>
</tr>
<tr>
<td>Construction Management and Economics</td>
<td>30</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Journal of Construction Engineering and Management</td>
<td>70</td>
<td>66</td>
<td>4</td>
</tr>
<tr>
<td>International Journal of Project Management</td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Project Management Journal</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Journal of Management in Engineering</td>
<td>34</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Other Sources</td>
<td>28</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>TOTAL</td>
<td>458</td>
<td>328</td>
<td>130</td>
</tr>
</tbody>
</table>

During the coding process, the author created parent and child nodes to answer the research questions, categorized the information according to the appropriate code, and interpreted outcomes to summarize current practices and develop a conceptual framework for implementing an integrated approach.

Chang (2014) points out that to address problems more systematically, setting out a framework is useful; therefore, as a result of the systematic literature review, the author developed a conceptual framework to facilitate IPD implementation. The conceptual framework also describes the attitudes that will enable IPD implementation and a potential organizational structure for integrated projects. The conceptual model can serve as a guide or framing mechanism for practitioners to explore the applications of IPD principles and tools and consider the expected behaviors that will facilitate IPD implementation by aligning stakeholders’ goals and expectations.
1.5.2.2 Case Study (Phase 2)

In the first phase of the study, the author developed a systematic literature review to analyze the landscape of IPD in practice, such analysis gives an overview of the implementation of an integrated approach for building construction projects around the world. Later, a case study is conducted to explore the whys and hows of a contemporary phenomenon or a single setting in its real-world context (Rowley, 2002; Yin, 2009; Eisenhardt, 1989), and in this case, the study aims to analyze the phenomenon of integration in a new market. The findings of the systematic literature review were then explored within a case study in Peru as an inductive approach to validate and expand their application and explore the potential advantages and disadvantages of IPD as well as the main motivations and barriers to its application. Because IPD is relatively new in Latin America’s construction industry, the case study method allows the author to analyze and better understand its implications and explore the applicability of the IPD approach to Peruvian culture. To be more specific, the study focuses on infrastructure projects in Peru. Therefore, the author focused on one of the leading organizations in Lean implementation with an emphasis on the construction of one of the largest infrastructure projects in the country. It is important to highlight that at the moment this study was developed, the company under study was the only one in the market trying to apply such integrated approach in building one of its largest infrastructure projects. Therefore, the case study allowed the author to compare the framework with current practices of the project aiming to practice IPD.

The case is focused on a Peruvian holding company composed of firms with development, engineering, construction, and operations/maintenance missions and competencies. While the company can deliver a PPP project largely by itself, the challenge is to coordinate and integrate all firms involved so that they act for the good of the whole instead of trying to optimize each of their parts individually. The main obstacles to integration include (1) the incompatibility of the current management system to integration, (2) the lack of procedures to instigate integration, and (3) the need for alignment mechanisms (KPMG, 2013). Consequently, integration needs to be fostered throughout the structure of the organization to improve project performance and the quality of the work environment. The unit of analysis was an ongoing construction project from the infrastructure division. For the case study analysis in the sample company in Peru, one of the instruments the author used for
collecting data was a questionnaire that was built by the author based on the findings from a thorough review of the existing literature which was performed through a systematic process and active review by third persons such as collaborators and advisors and was distributed by LCI Peru as an official institution working on improving construction industry in Peru. The survey provided an opportunity to identify participant expectations and current practices.

The scope of the research for the case study was limited to professionals working on the construction of infrastructure projects for one of the largest construction firms in Peru that deal with large-scale, complex projects. Site visits were conducted during the construction phase of the project being considered in the case study to better understand the project scope, and further discussions with the project team members were conducted to help analyze the data collected from the case study. As part of an in-depth analysis for the perception of participants in the case study regarding specific topics of IPD, the author developed a detailed questionnaire and 30 people from the case study were invited to participate. LCI Peru distributed the questionnaire to the project participants in the case study and 26 were returned, resulting in a response rate of 87%.

Thus, in this phase of the study, the author explored the potential applications of the IPD principles identified from the systematic review through a case study of the first pilot project in Peru that adopted IPD as a delivery method. This case illustrates the trade-offs the project team faced during the project’s execution. The project team’s expected behavior impacted the author’s suggestions for further improvement. Participants behavior and expectations played an important role in the course of the research since they will guide any future actions related to the project.

For example, it is notable that although the participants believe that people in their organization are knowledgeable about Lean construction and they have used it to some extent; there remains a lack of knowledge about how to use IPD as a delivery method. This phase of the study attempts to provide data concerning the level of knowledge professionals in the infrastructure division have regarding Lean construction, BIM, and IPD, as well as their willingness to change current practices and to move to a more collaborative environment.
A qualitative approach was chosen for the study because IPD has not been applied widely in the Peruvian sector, and a qualitative approach is an appropriate method for studying different aspects of a small number of cases and it allowed the author to gain the initial knowledge of practitioners (Ragin, 1994). The author and a member of LCI Peru’s Academic Committee analyzed one of the major consultant company’s report, Klynveld Peat Marwick Goerdeler (KPMG, 2013), in which major causes for project failures were highlighted and subsequently identified the major issues affecting the Peruvian construction industry and the issues industry practitioners need to work on to increase their competitiveness in the market. The following problems were identified: i) lack of an integrated management system, ii) lack of a process for structuring an integrated team, iii) absence of planning and evaluation for the feasibility of execution, and iv) lack of alignment mechanisms. The case study developed in phase 2 of the research aims to analyze the extent to which certain IPD principles were applied in the studied project.

As part of the case study, a questionnaire was sent out through LCI Peru to analyze the specific practices of one company, and all the survey participants belonged to one particular project in the infrastructure division. The author then conducted an extensive survey through LCI Peru of professionals in the same company who were involved in the delivery of infrastructure projects in general. The goal of the first survey conducted throughout one sample company was to gauge the stakeholders’ perceptions and expectations concerning their involvement in a collaborative delivery model and evaluate their current practices. Basic questions about the respondents, their projects, and their understanding of Lean, BIM, and IPD were asked first, followed by questions related to the understanding of integration and its connection to project success. Once the survey results were collected, the cultural context was analyzed and helped to inform the general ideas that should be addressed in phase 4 of the study with a bigger population of individuals who belonged to partner companies of LCI Peru. This information also helped determined further steps for project delivery improvement.

1.5.2.2.1 Case Study Data Collection

The author developed an extensive survey that was distributed through LCI Peru to the participants in the case study. The questionnaire developed for the case study was
distributed to the study’s targeted population using an electronic platform called SurveyMonkey. A survey link was emailed to the participants through LCI Peru and the author received all the responses for processing and reporting. The demographics of the project under study is discussed in detail in the Respondents subsection below. A sample group of 3 practitioners inside the company was chosen to test and validate the clarity of the questions before the survey was widely distributed, such participants along with the author presented preliminary results of the study in the Lean Construction Institute Congress in Los Angeles, California in 2017.

For the case study, 30 people from the company in the case study who were involved in the delivery of infrastructure projects were invited to participate in the survey. Participants held various roles from project manager and chief field engineer to technical office engineers among others (Table 1.2). LCI Peru, as an organization representing Lean in the construction industry, was responsible to send the surveys out to the participants, resulting in a total of 26 completed surveys in the case study. Although the number of sample points is too small to be statistically significant, the outcomes gave the author the first hints on different aspects about the applicability of IPD for infrastructure projects in the sample case study in Peru.

1.5.2.2.2 Participants

Participants of the study were all involved in the construction of infrastructure projects in Peru. The author through LCI Peru invited 30 people from one company who were involved in the delivery of infrastructure projects for analyzing a detailed case study; this phase included responses from different roles such as project managers, chief field engineers, technical office engineers, and others (see Table 1.2 for detailed information). The author included a variety of questions regarding IPD, and LCI Peru sent the survey out to the participants, receiving a total of 26 completed surveys out of the 30 that were sent out, which yields an 87% participation rate. All respondents had been involved at some point in time with infrastructure projects in Peru, most of them in the way of Public-Private Partnership (PPP), such as Linea 1 metro of Lima (PPP), Line 1 expansion project (PPP), Linea 1 operations concession (PPP), Linea 1 second expansion (PPP), Cayetano Heredia hospital (PPP), Quellaveco mining project, and Cerro del Aguila hydroelectric project.
Table 1.2 Participant Role Distributions for the First Survey (Phase 2 of the study)

<table>
<thead>
<tr>
<th>Role</th>
<th>Number of Participants</th>
<th>Percentage per Role (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>14</td>
<td>53%</td>
</tr>
<tr>
<td>Designer or Specialist</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Technical manager</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Field Engineer</td>
<td>3</td>
<td>11.5%</td>
</tr>
<tr>
<td>Technical Office Engineer</td>
<td>3</td>
<td>11.5%</td>
</tr>
<tr>
<td>Administrative Area</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>26</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Outcomes of the systematic literature review and the case study findings guided the next phase of the research which presents a broader analysis of the construction industry in Peru and the author analyzed IPD suitability in such an environment. Data collected from the case study was synthesized and presented in Chapter 4.

1.5.2.3 Survey (Phase 3)

The survey conducted in the 3rd phase of the research was also conducted through LCI Peru and the author analyzed survey outcomes and included them in this research. The extensive survey was distributed to a major sample of people (100 participants) and were focused on identifying the gap between the conceptual framework proposed by the author and the current state of Peruvian construction industry practices. The survey also included open-ended questions to gather more insightful data. It included inquiries regarding various IPD principles, the tools being used in their projects, and their commitment to continuous improvement.

The online questionnaire developed in this phase of the study was also designed to determine the respondents’ level of awareness, experience, motivation, and willingness to adapt new systems with regard to IPD and the gaps between the proposed conceptual framework and current practices in the Peruvian construction industry, particularly those
in the field of infrastructure construction. Complete versions of the questionnaires included in the case study and the third phase of the research are presented in Appendix A and Appendix B respectively.

The following are some of the questions the author aimed to have answered through the questionnaires:

1. What is the current status of IPD adoption (in terms of the practices, principles, and tools provided in the proposed framework) throughout the construction industry for infrastructure projects?

2. What is each stakeholder’s the level of involvement in the decision-making process?

3. What are participant expectations for the way the delivery method of their projects? Do people want to change the way they are doing things?

4. Does the lack of experience with IPD and other collaborative delivery methods in Peru impact the feasibility of its implementation?

1.5.2.3.1 Broad Survey Data Collection

After developing the case study, the author expanded the analysis for the Peruvian construction market by using outcomes of a data collection instrument developed through LCI Peru. A survey was distributed to the study’s targeted population using the online platform called SurveyMonkey. LCI Peru sent the survey link through email to the participants and the author received all the responses for processing and reporting in the monthly meetings held by the Academic Committee of LCI Peru. The demographics of the projects that were considered are discussed in detail in the Respondents subsection.

In this phase, the survey included 100 participants from a variety of companies that are partners of LCI Peru. Role of the participants varies from project manager and chief field engineer to technical office engineers among others (Table 1.3). A total of 75 completed surveys were received. Although the number of sample points is too small to be statistically significant, the outcomes gave the author the first hints on different aspects about the applicability of IPD for infrastructure projects in Peru.
1.5.2.3.2 Respondents

Employees from 21 LCI Peru partner companies participated in this phase. Participants of the study were all involved in the construction of infrastructure projects in Peru in different companies that are corporate members of LCI Peru. In phase 3 of the study, the author through LCI Peru invited 100 people including project managers, chief field engineers, technical office engineers, and others (see Table 1.3 for detailed information). The author included a variety of questions regarding IPD, and LCI Peru sent the survey out to the participants, receiving a total of 75 completed surveys out of the 100 that were sent out, which yields an 75% participation rate. This phase allows the author to identify the gap between current practices in the Peruvian construction industry and those proposed in the conceptual framework to better propose a path for improvement. The survey included an extensive set of questions covering the following categories: wisdom or knowledge of IPD practices, strategies for continuous improvement or mindfulness on the topic, leadership roles, and any efforts being made to promote integration in the Peruvian construction industry.

Table 1.3 Participant Role Distributions for the Second Survey (Phase 4 of the study)

<table>
<thead>
<tr>
<th>Role</th>
<th>Number of Participants</th>
<th>Percentage per Role (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>16</td>
<td>21%</td>
</tr>
<tr>
<td>Designer or Specialist</td>
<td>20</td>
<td>26%</td>
</tr>
<tr>
<td>Project Controls Engineer</td>
<td>9</td>
<td>12%</td>
</tr>
<tr>
<td>Field Engineer</td>
<td>8</td>
<td>11%</td>
</tr>
<tr>
<td>Technical Office Engineer</td>
<td>11</td>
<td>15%</td>
</tr>
<tr>
<td>Quality Assurance / Quality Control (QA/QC) Engineer</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Administrative Area</td>
<td>8</td>
<td>11%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>75</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

A guideline for a successful implementation of IPD was proposed in the first phase of the study. Then, through phases 2 and 3, the author analyzed the applicability of the proposed
framework in a sample case study and expanded the analysis to the Peruvian construction industry.

1.5.2.4 Refinement of the Framework and Plan for Improvement (Phases 4 and 5)

Discussions were conducted during LCI Peru Academic Committee monthly meetings where the author is also a member of such committee. Other committee members include employees from different companies with relatively medium or high levels of experience applying Lean construction in their projects. Among the items that were discussed in such meetings, the author explained the results from the questionnaires and then presented the conceptual framework developed in the study. Later, the author also introduced the plan of action for improving the current state of the construction industry in Peru, particularly concerning infrastructure projects, which involve multiple players in the building process. Such a successful implementation of IPD is expected to bring the benefits identified in chapter 3, section 3.2. The benefits of IPD implementation in Peru would include stakeholder satisfaction and improved project outcomes with regard to cost, schedule, and quality among others.

In terms of the study structure, chapter 4 is where the author attempts to improve the proposed conceptual framework and identifies motivational aspects to help convince participants to change current construction practices in Peru. While this part of the study uses data from 21 different companies in Peru to analyze the feasibility of IPD implementation, only one case study of IPD application was extensively analyzed. In addition to the systematic literature review, the analysis of the case study and the responses from the extensive questionnaire sent out through LCI Peru were used to adjust the conceptual framework. A significant amount of information for improving the proposed framework was gathered from the meetings with the LCI Peru Academic Committee, and input came from practitioners who were knowledgeable of IPD and Lean construction. The discussions with the committee were conducted for two main purposes: i) to get feedback on the proposed conceptual framework and improve the initial model and ii) to analyze how tangible changes can occur in the next 15 years in the Peruvian construction industry.
1.5.2.4.1 Work Sessions with LCI Peru

As a community of practice that aims to foster Lean throughout the construction industry in Peru, LCI Peru goal is published on its website and it says that the group aims to “generate a community that develops awareness in the Lean Construction philosophy and achieve a higher productivity index in the construction industry of Peru through different means of dissemination, training and development of the philosophy.” LCI Peru has three different committees and one of them is the LCI Peru Academic Committee which is in charge of fostering continuous improvement by engaging new practitioners into the Lean thinking and leveraging the Lean advantage throughout the construction community in Peru. The number of attendees for each monthly meeting varies between 10 to 15 participants, all of them practitioners in the construction industry. The author as a member of the academic committee attended the meetings through Skype calls from USA. The academic committee has a yearly agenda with different topics and parts of this research from chapter 3 and 4 were presented during the monthly meetings of the committee for disseminating information and generating discussion to improve current industry performance. Time for discussion on diverse topics is allotted in the agenda and each meeting duration is about 3 hours long in which around half hour was devoted to each topic. The topic of this research was included in around 8 meetings where results were chosen and discussion from practitioners was encouraged to get constant feedback on the subject.

1.6 Expected Results

IPD implementation is supported by the principles that aim to improve the performance of a project based on intrinsic practices of organizations. The focus is on practices that follow the patterns of integration through the use of a set of tools and methods to facilitate its implementation. One contribution of this study is a systematic and categorized synthesis of research on integrated practices in the construction industry. Therefore, this study will conclude with a plan of action for application of IPD in practice in the construction industry. Also, a discussion about the potential challenges in implementing the proposed framework that companies might face is included, this might change depending on the kind of project
they are working on and Peruvian cultural nuances. In order to achieve this goal, the proposed framework will be used as a basis for the analysis.

1.7 Thesis Organization

This thesis is organized into five chapters. Chapter 1 introduces the research background and needs, the research statement, and corresponding research objectives and also expands on the study’s foundations by providing a detailed description of the research methodology. In chapter 2, a general literature review is conducted on project delivery systems and how the complexity of projects has grown over the years along with construction issues and owners’ dissatisfaction. In addition, a systematic literature review is conducted on IPD to better understand how it has been successfully applied in practice. Infrastructure projects are emphasized in this process due to the high levels of complexity that they involve. Chapter 3 develops the proposed conceptual framework using the outputs of the systematic literature review from chapter 2. The framework includes the principles, tools, and governance structure that shall govern an integrated project. In order to identify the gap between the proposed framework and the current state of practice for infrastructure projects in Peru, chapter 4 is divided into two major topics. First of all, it develops an extensive analysis of a sample case study in a Peruvian construction company that is trying to use IPD for the construction of one of its infrastructure projects. Second, the author included a broader analysis of the current Peruvian practices aiming to compare and contrast certain areas of the conceptual framework proposed to get a better understanding of which areas need major improvement. Lastly, the study deeply analyzes in both cases key points of the conceptual framework such as the use of the last planner system for short-term and long-term planning. Such comparison allowed the author to identify potential areas of improvement in the different areas of knowledge that LCI introduced and will be described later in the research. This chapter also presents recommendations for continuous improvement and a plan of action for the next 15 years to reduce the gap identified earlier. It should be noted that in this thesis, chapters 3 and 4 are written as two separate research papers. And as separate research papers, each chapter includes its own introduction, literature review that might overlap with some of the content from chapter 2, technical content and conclusion.
Chapter 5 presents the study’s conclusions and a discussion on the findings that resulted from this research. The study’s limitations are also presented in this chapter along with recommendations for future research focused on the Peruvian construction sector.
2. LITERATURE REVIEW

2.1 Complexity and Issues of Construction Projects

Architecture, engineering, and construction (AEC) companies have been failing to meet the project owner’s performance expectations or customer requirements, resulting in the disruption of progress for a given project (Lichtig, 2006; Ballard et al., 2007). Due to the tendency of the construction industry in applying traditional methods, a number of issues such as rework, time delays, higher costs than expected, a lack of understanding, and poor support plague the construction sector (Nawi et al., 2014a). As a consequence of these numerous issues, productivity in construction has been decreasing over time, Changali and van Nieuwland (2015), from McKinsey and Company, used data from the World Input-Output Database (WIOD) to provide an overview of the decrease in construction productivity that has occurred (see Fig. 2.1). According to some researchers, poor project performance and client dissatisfaction can be attributed to different causes such as fragmentation or “the silo effect” that obstructs coordination and integration in construction operations (Paik et al., 2017; Walker et al., 2016; Xue et al., 2005; Harper, 2016) from the point of project conceptualization till the operation and maintenance of newly built facilities. In addition, the lack of leaders who understand and are willing to commit to new systems means that companies are failing to get the best performances from a project’s team members (Fernandez-Solis et al., 2013), and other causes regarding human behavior have been advanced as well, many of which further highlight the lack of coordination and integration in the industry. Similar issues have been reported in the Peruvian construction market: issues linked to the lack of integration and the misalignment of goals between stakeholders (Canales 2014).

Because of such issues, there has been an increasing number of disputes and a rise in their severity (Mesa et al., 2016). Fernandez-Solis et al. (2013) identified the following as some of the challenges that the construction industry is currently facing:

1. organizational inertia,
2. a lack of commitment or negative attitudes towards new systems,
3. a lack of human capital,
4. a lack of stakeholder support,
5. a lack of empowerment of field management,
6. poor use of information,
7. bad team chemistry or lack of collaboration,
8. bad work ethics and cultural issues,
9. short-term vision.

Moreover, due to the collective relationships between different stakeholders and the competitive budgets and schedules involved, construction projects are often seen as complex undertakings (Nawi et al., 2014a; Palacios et al., 2011). The process of designing, constructing, and operating new facilities and the interactions between the different stages are particularly complex (Wood and Gidado, 2008). Ballard et al. (2007) have highlighted how over time there has been a trend of projects changing from being simple, certain and slow to being more complex, uncertain and quick (see Fig. 2.2). The construction industry over the years has been described by many authors (Mills, 2001; Aapaoja, 2013; and Zhang et al., 2013) as one of the most dynamic, risky, with high uncertainty, and challenging industries. Construction projects are unique in its kind and full of uncertainties (Liu 2013);
therefore, dealing with such high levels of risks and uncertainties requires effective cross-
team collaboration between all project participants involved is required to successfully
deliver a project (Walker et al., 2016). Complexity requires an integrated approach, which
is achievable in an integrated project delivery (IPD) environment (Demirkesen and
Ozorhon, 2017). IPD was developed to address the challenges presented by the increasing
complexity of construction projects and aims to foster a culture where collaboration is
embedded in all individuals involved (Bilbo et al., 2015; Sun et al., 2015).

Figure 2.2 Increase in project complexity over time (Ballard et al., 2007)

As complexity and uncertainty increases in projects, according to Zhan and Wang (2009)
more effort is required in early stages of projects since the ability to impact cost and
functionality is higher earlier in the project (Figure 2.3). Seed (2014) also suggested that
the most impactful time to improve the project is during design.

Figure 2.3 Value Added and Cost of Changes (Zhang and Wang, 2009)
2.2 Project Delivery Systems

“The history of project delivery systems is as old as the history of buildings and construction” (Ballard et al., 2011, p.17) and it has been evolving since the creation of the master builder model of Ancient Greece (Jackson, 2010). A project delivery system defines the sequence in which a project will be built while setting the organizational structure and responsibilities of all parties involved; it looks for the alignment of the three basic domains of operating systems, project organization, and commercial terms (El Asmar et al., 2013; Ballard et al., 2012; Thomsen, 2006; LCI, 2017; Miller et al., 2000; Oyetunji and Anderson, 2006; Dorsey, 1997; ASCE, 2000; AIA, 2007; Kenig, 2004; Kenig et al., 2010; Konchar and Sanvido, 1998; Ireland, 1984; CMAA, 2012; Moynihan and Harsh, 2015; Chen, 2011; Kenig, 2011; Alarcon et al., 2013; Smith and Rybkowski, 2012). Sarkar and Mangrola, (2016) listed “11 project delivery systems used in present times such construction management at risk (CMR), design/build (DB), design/bid/build (DBB), engineer-procure-construct (EPC) projects, fast-track construction” among others and highlighted the fact that project delivery systems have continued to evolve over recent decades. El Asmar et al. (2013), Liu (2013), Ghassemi and Becerik-Gerber (2011), and Konchar and Sanvido (1998) suggest that the three delivery systems most commonly employed in the construction industry are i) DBB, ii) DB, and iii) CMR. However, these traditional delivery methods are problematic because they foster individual mindsets instead of encouraging collaboration (Aapaoja, 2013).

Still, it is undeniable that construction projects can be delivered through different project delivery systems. Some researchers (Franz et al., 2017) have highlighted how the project delivery method used directly impacts the level of team integration and group cohesion. Numerous researchers have studied the advantages of individual delivery systems and compared them to others (Bennett et al., 1996; Sanvido and Konchar, 1998; Ibbs et al., 2003; Rojas and Kell, 2008; Korkmaz et al., 2010). Also, other researchers (Mesa et al., 2016) have studied how the project delivery system affects the supply chain, which in turn affects overall project performance. In the last few decades, organizations have been shifting their focus from the delivery of products to the generation of value for the client and end users (Winter and Szczepanek, 2008).
A common belief among practitioners and researchers entails that collaborative methods will enhance project outcomes and improve stakeholder relationships. Based on this belief, the need has been set to adopt more collaborative methods that allow deeper levels of involvement and aid in aligning stakeholders interests so that decisions can be made for the best of a given project (Sakal, 2005). Moreover, in the construction industry worldwide, collaboration and cooperation have become increasingly common (Jacobsson and Roth, 2014; MacDonald and Mills, 2013). Particularly in construction, collaboration plays a key role in delivering successful projects and overcoming the complexities found in the industry (Elvin, 2007). Project delivery systems are chosen in order to define how a product will be delivered. As shown in Fig. 2.4, a conversation needs to happen to create harmony between what the client needs and how it will be delivered given certain limitations.

![Figure 2.4 Project Definition Process (after Ballard, 2008, "The Lean Project Delivery System: An Update")](image)

Among different delivery methods that have been developed in construction, IPD aims to lead the team on a collaborative path where the mindset is on what is best-for-project at hand and participants are looking for overall improvement (Azhar et al., 2014) to consequently reduce later conflicts such as extended schedules, cost overruns, and lengthy disputes. Among the different collaborative methods available, IPD has gained popularity due to its benefits when dealing with complex projects (Ballard et al. 2011). These benefits are easy to see when complexities arise (Zimina et al., 2012). Moreover, other researchers
(Ma et al., 2017; Rooney, 2009) have highlighted how increasing collaboration, bringing stakeholders in early, and establishing pain/gain mechanisms helps to solve or eliminate major problems in construction. For some researchers, IPD is considered the highest form of collaboration in construction (Liu, 2013). It has shown the greatest benefits when the emphasis is on the delivery of greater value to clients while providing a venue for collaboration where the value is co-created by all parties.

IPD is also known by some researchers as the Lean Project Delivery System (LPDS), the Lean Project Delivery (LPD), or the Lean Integrated Project Delivery (LIPD) (Mossman et al., 2010; Kenig et al., 2010; Kim et al., 2016; Ballard, 2000a; Do et al., 2015). Integration has been used in a variety of ways in the construction industry, and different principles and tools have been applied in practice. There has been extensive research done through case studies on IPD, how it relates separately to the project environment and a supply chain, and ultimately its overall impact on project outcomes (Mesa et al., 2016; Dossick et al., 2013; El Asmar et al., 2013; Ghassemi and Becerik-Gerber, 2011). However, there remains a lack of study on how the context and extent of integration in the construction industry as a whole.

Regardless of the contractual agreement used in a given project, project teams can choose their preferred delivery method (i.e., the way the team will execute the project) by applying certain principles, tools, and behaviors. Over time, there has been the acknowledgement that human behavior can be fostered to hold an integrated mindset where participants look to deliver the greatest value to their clients. Previous studies (Chen and Manley, 2014; Cheng et al., 2012) support the fact that IPD cannot be reduced to a contractual agreement because contractual conditions are not sufficient to optimize project performance since a contract by itself will not create the cultural shift needed for the co-creation of greater value in project delivery (Jacobsson and Roth, 2014; Kenig et al., 2010).

2.3 Traditional Delivery Systems

2.3.1 Design-Bid-Build

Gokhale (2011) highlighted Design-Bid-Build (DBB) as one of the most basic delivery methods and the top choice for public projects which very often tend to prioritize the lowest
price for a project. In this scenario, parties fight against each other and try to optimize their own benefits without a minimum level of care for the final quality of the product; thus, only the minimum requirements of satisfaction are fulfilled. McKew (2011) points out that DBB projects are budgeted with little or no input from trade partners and end up having cost overruns of around 9% to 12%.

### 2.3.2 Construction Management at Risk

With construction management at risk (CMR), Gokhale (2011) argues that the contractor acts as a vendor who is in charge of managing the design, budgeting and bid phases. The nature of the agreement tends to be transactional (Kenig et al., 2010).

### 2.3.3 Design-Build

In the Design-Build (DB) method, a single entity is in charge of delivering the design and construction of the project (Gokhale, 2011; Fish, 2011). The nature of the agreement is similar to that of the CMR approach, which tends to be transactional (Kenig et al., 2010). Numerous researchers have studied the project performance outcomes delivered through DB (Molenaar et al., 1999; Songer and Molenaar, 1996; Konchar and Sanvido, 1998; Chan et al., 2002), and they have done so through the analysis of metrics such as cost, schedule, and turnover quality among other indicators in the different phases of a project. Even though the owner is benefited in some way because he only has to look for one party, the owner might not receive the benefits of having an integrated project (Fish, 2011).

### 2.4 Collaborative Methods in Construction

In recent years, the construction industry has been moving towards integration with the aim of successfully delivering projects by increasing collaborative efforts (Suprapto et al., 2015; MacDonald and Mills, 2013; Taylor and Olsen, 2012), and there have also been strong incentives for expediting the delivery of infrastructure projects (Gokhale, 2011). Beard et al. (2001) highlighted that the fact that one single entity was responsible for the design and construction of buildings beginning in the Babylonian era (1795–f 1750 BCE), and centuries later the architect Vitruvius supported the same principle, leading to the
origination of the term “master builder” for the person who was ultimately responsible for the whole project’s delivery.

Consequently, the execution of project phases such as design, construction, operation, and maintenance has been developed and overseen by a single entity (Do et al., 2015). However, collaborative methods in form of project alliances have been widely applied in Australia and the United Kingdom (Ashcraft, 2011b). Lahdenperä (2012) has highlighted project partnering, project alliancing, and integrated project delivery as the most standout collaborative approaches. Such collaborative methods in construction allow a deeper level of involvement and align the project teams so that they can make decisions for the betterment of the project (Sakal, 2005). Some researchers have suggested that the difference between project alliancing and IPD is that in IPD projects the project delivery team works as a single organization under a single contract and shares any risks or rewards (Aapaoja, 2013). However, others (Lahdenperä, 2012; Lichtig, 2006) suggest that the difference between project alliancing and IPD lies in the implementation of Lean tools and principles in IPD projects. IPD is changing the current state of the fragmented construction industry, its segregated processes, and its culture of secrecy to foster integrated teams, multilevel delivery processes, and an open culture of communication and knowledge sharing (Liu, 2013).

2.4.1 Project Partnering

Lahdenperä (2012) highlighted the conservative approach of project partnering, a delivery method that emerged in US in the late 1980s and was used later in the UK and Australia. Egan report titled "Rethinking Construction" from 1998 states that "Partnering involves two or more organizations working together to improve performance through agreeing mutual objectives, devising a way for resolving any disputes and committing themselves to continuous improvement, measuring progress and sharing gains". In addition, the Construction Industry Institute website (CII, 2018) has defined Partnering as: “A long-term commitment between two or more organizations as in an alliance or it may be applied to a shorter period of time such as the duration of a project. The purpose of partnering is to achieve specific business objectives by maximizing the effectiveness of each participant’s resources.” Partnering was developed to guide and promote cooperation (Lenard et al.,
1996); however, any gains or losses are not tied to the success or failure of the team (Walker et al., 2002).

### 2.4.2 Project Alliancing

Lahdenperä (2012) and Hauck et al. (2004) recognize project alliancing as a common project delivery system that emerged in the UK in the mid 90’s in Australia to deal with fragmentation, and according to the Alliancing Association of Australasia (2009), alliancing adopts key elements of partnering. Alliancing projects include commercial terms in a contract in the form of financial incentives for good project performance, thus creating win-win or lose-lose scenarios (Manley, 2002; Hauck et al., 2004). The Department of Treasury and Finance Victoria (2006 pg. 2) stated that in project alliancing, “the state or another government entity collaborates with one or more service providers to share the risks and responsibilities in delivering the capital phase of a project”. Project alliancing is seen by Walker et al. (2002) as one of the most similar delivery methods compared to IPD since the success of alliances is also based on good disposition of the project team members (Mignot, 2009).

### 2.4.3 Integrated Project Delivery System

Integrated Project Delivery (IPD) has emerged as an alternative approach for delivering value to clients, addressing many of the challenges presented in traditional construction, and improving overall project performance by aligning stakeholders interests and objectives while integrating people, systems, and practices through all phases of construction projects (Aapaoja et al., 2013; Mesa et al., 2016; Mossman et al., 2011; Do et al., 2015; Kim et al., 2016; AIA, 2007; Mah et al., 2016; Matthews and Howell, 2005; Sun et al., 2015; Alp and Franz-Joseph vonWerssowetz, 2013; Ghassemi and Becerik-Gerber 2011; Lichtig, 2006; Bilbo et al., 2015). Instances of IPD projects transitioning from an individual mindset to a collaborative approach improving team integration have been documented by practitioners and academic researchers (Walker et al., 2016; Cohen, 2010; Forero et al., 2015; Mollaoglu et al., 2013; Azhar et al., 2014) supporting the fact that IPD is not just a utopian vision (Khemlani, 2009). IPD works when individuals are in the social exchange framework to make and keep commitments (Mossman et al., 2011; Hellmund et
al., 2008) and it relies on highly trust-based collaboration within all stakeholder (Zhang et al., 2015) supported in some case by a relational agreement considered by some authors as the hallmark of IPD (Kenig et al., 2010; Darrington, 2011). The Construction Industry Institute (CII, 1996) called for a cultural change that embrace collaboration in the construction industry. IPD fosters a cultural change towards collaboration (Suttie, 2013) and it requires a team thinking approach because it aims to create a harmony between different elements that need to fit together, and it needs the buy-in from all players to successfully work (Daswani et al., 2015). Although IPD has primarily been applied to the design and construction phase of projects, the project is shaped and delivered with an eye to the entire lifecycle of the constructed asset (Alp and Franz-Joseph vonWerssowetz, 2013; Cohen, 2010; Fish, 2011; Ballard, 2008). Consequently, IPD is a good fit for infrastructure projects delivered in the form of private-public partnership (PPP) due their high complexity.

In US construction industry, clients have been leading the change requiring AEC companies to work collaboratively and improve their performance in the delivery of capital projects. One of the pioneers in the field is Sutter Health and Will Lichtig had documented their lean journey and described it the chapter “The Integrated Agreement for Lean Project Delivery” of the book “Improving Healthcare through Built Environment Infrastructure” (2006) in which he also described the five big ideas of Sutter Health’s Lean Project Delivery (Fig. 2.5) and the integrated form of agreement used in IPD projects.

![Figure 2.5 The Five Big Ideas of Lean Project Delivery (Lichtig, 2006)](image-url)
No consensus has been established in the industry as a whole regarding IPD definition (Ibrahim, 2013). However, while consensus on IPD definition remains elusive, it is in process of on-going development and some authors used or supported the following definitions found in the literature:

Table 2.1 IPD Meaning from Different Authors

<table>
<thead>
<tr>
<th>Author</th>
<th>Definition</th>
<th>Authors supporting the same definition</th>
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<tr>
<td>AIA/AIACC (2007), AIA 2009</td>
<td>“IPD is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction”.</td>
<td>AIA, 2007; Sarkar and Mangrola, 2016; Pishdad-Bozorgi and Beliveau, 2016a; Khemlani, 2009; Ballard et al., 2012; Mah et al., 2016; Zhang et al., 2015; Kim et al., 2016; Teng et al., 2017; Forero et al., 2015; Duke et al., 2010; Ke et al., 2015; Sun et al., 2015; Moynihan and Harsh, 2015; Azhar et al., 2014; Nawi et al., 2014b; Zhang and Li, 2014; Rached et al., 2014; Alp and Franz-Joseph vonWerssowetz, 2013; Aapaoja et al., 2013; Zhang et al., 2013; Melo et al., 2013; Smith and Rybkowski, 2012; Tillmann et al., 2012; Aapaoja et al., 2012; Nanda et al., 2016; Gokhale, 2011; Ghassemi and Becerik-Gerber, 2011; Kent and Becerik-Gerber 2010; Zhang and Wang, 2009; Gupta et al., 2009</td>
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<td>Cohen, 2010</td>
<td>“IPD is a method of project delivery distinguished by a contractual arrangement among a minimum of owner, constructor and design professional that aligns business interests of all parties. IPD motivates collaboration throughout the design and construction process by tying</td>
<td>Cohen, 2010; Cheng et al., 2012; Pishdad-Bozorgi and Beliveau, 2016a; Mossman et al., 2010; Collins and Parrish, 2014; Cho and Ballard, 2011; Ghassemi and Becerik-Gerber 2011</td>
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<td>Author</td>
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<td>Mossman et al., 2011;</td>
<td>“IPD has emerged from rethinking the end-to-end design, construction and use where value is the raison d’être and it works when individuals make and keep commitments”</td>
<td>Mossman et al., 2011; Mossman et al., 2010</td>
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<td>Cheng et al., 2016</td>
<td>“IPD is a contractual project delivery method used by project teams that created shared risk/reward structures, fiscal transparency, and release of liability”</td>
<td>Cheng et al., 2016;</td>
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<tr>
<td>Liu and Bates, 2013</td>
<td>“IPD is a trust-based, risk and reward sharing, highly collaborative system with open communication and transparent accounting strategy”</td>
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<td>Anderson, 2010</td>
<td>“IPD as a business model for design, execution, and delivery of buildings by collaborative, integrated and productive teams composed of key project”</td>
<td>Anderson, 2010; Nawi et al., 2014b</td>
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<td>AIA 2014</td>
<td>“IPD is defined as a project delivery method 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”</td>
<td>AIA 2014; Hall, 2017; Fakhimi et al., 2016; Ma et al., 2017</td>
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<td>AIA 2014</td>
<td>stakeholder success to project success and embodies contractual principles and behavioral principles”.</td>
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<td>El Asmar et al., 2013</td>
<td>“IPD as an emerging construction project delivery system that collaboratively involves key participants very early in the project timeline, often before the design is started. IPD is defined as a delivery system distinguished by a multiparty agreement and the very early involvement of key participants”</td>
<td>El Asmar et al., 2013; El Asmar et al., 2015</td>
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<td>Ballard, 2000a</td>
<td>“LPDS is envisioned as a project delivery method that conceptualizes design and construction projects as lean production systems”</td>
<td>Ballard, 2000a; Khanzode et al., 2006</td>
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<td>Matthews and Howell, 2005</td>
<td>“IPD is an alternative project delivery that supports aligning interests, objectives, and practices, and it explicitly promotes shared risk and reward and extensive collaboration between project parties”</td>
<td>Matthews and Howell, 2005; Kim et al., 2016; Teng et al., 2017; Sun et al., 2015</td>
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<tr>
<td>P2SL, Glossary</td>
<td>“A delivery system that seeks to align all project team members’ interests, objectives, and practices (even in a single business), through conceiving the Organization, Operating System and Commercial Terms governing the project. Team members would include the architect, key technical consultants as well as a general contractor and key subcontractors.”</td>
<td>P2SL, 2018</td>
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It creates an organization able to apply the principles and practices of the Lean Project Delivery System.”

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<tr>
<td>LCI Glossary</td>
<td>“A delivery system that seeks to align interests, objectives and practices, by reconceiving the organization, operating system and commercial terms governing the project. The primary team members would include the architect, key technical consultants as well as a general contractor and key specialty contractors. It creates an organization able to apply the principles and practices of the Lean Project Delivery System.”</td>
<td>LCI, 2017</td>
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IPD requires a paradigm shift that supports lean thinking throughout the entire lifecycle of the project (Lichtig 2007; Nanda et al., 2016; Azhar et al., 2014; Naney et al., 2012) and most definitions support this statement. Khanzode et al. (2006) suggested that the lean project delivery system or integrated project delivery system provides a framework to structure the project in a way in which the lean ideal and principles will be better implemented.

Integration is “the sum of many things” (Aapaoja et al., 2013) and particularly in construction, integration considers the complex interactions of project tiers and the variety of disciplines and technical systems that are a part of construction projects (Ibrahim, 2013; Liu et al., 2016). The definition of integration in different disciplines might vary in focus and extent, but in all cases, integration has yielded improvements in project performance and supports the creation of positive, cooperative, and collaborative teamwork (Ibrahim et al., 2013; Latham, 1994; Egan, 2002; Constructing Excellence, 2004).
Baiden et al. (2006) define integration as a state “where different disciplines or organizations with different goals, needs and cultures merge into a single cohesive and mutually supporting unit with collaborative alignment of processes and cultures”. Meanwhile, Lawrence and Lorsch (1967) perceive integration as “the quality of the state of collaboration which exists among departments that are required to achieve unity of effort because of environmental demands”.

IPD aims to build cooperation and involve all members of a team as equals in the pursuit of a shared goal (Mossman, 2010; Fakhimi et al., 2016; Love and Gunasekaran, 1998; Baiden et al., 2003). The concept of integration is not new in the construction industry and it has multiple meanings in IPD; however, there is a consensus between researchers (Demirkesen and Ozorhon, 2017) that integration is key for successful project execution. Integration seeks for individuals with different backgrounds and expertise to learn from one another and solve problems as a team (Lichtig, 2005a). First comes organizational integration, which includes bringing downstream players into upstream processes, and vice-versa. Second is the integration of interests, both commercial and professional. Third is the integration of knowledge and skills. Fourth is the integration of information through information technology, including building information modeling (BIM). Therefore, integration can be understood as a different approach to performing tasks by taking advantage of the knowledge available from a wider range of team members to maximize the project outcome and deliver greater value to clients and end users. IPD aims to facilitate a higher form of collaboration within disciplines and across them.

Researchers suggest that integration is a key factor in the success of a project (Love et al., 2002). The goal of the systematic literature review with regard to integration was to assess how integration has been understood and defined in prior studies. Integration allows people to achieve value through savings in engineering, the delivery of projects on time or ahead of schedule, and the satisfaction of quality and safety expectations (Mesa et al., 2016). The primary goal of this section is to better understand the concept of integration in the context of IPD. Using the initial literature review, the author performed a content analysis and identified five categories of integration that compiled together yield a comprehensive definition of integration in the context of an IPD project. The five categories of “integration” in the context of construction are as follows: i) collaboration, ii) communication, iii)
alignment, iv) continuous improvement, and v) pain/gain sharing. The subject of integration explored within the five different categories identified by the author is detailed in this section. Each concept is thoroughly analyzed to present a general understanding of each term in Table 2.2.

2.4.3.1 Integration as Collaboration

“Integration is often used interchangeably with collaboration” (Kenig et al., 2010 pg. 4). Some researchers suggest that integration is based upon collaboration, which includes a common understanding of the overall project and the involvement of key participants, the project’s purpose, and what value means for the owner (AIA, 2007; Thomsen et al., 2010; Rahim et al., 2016; Zhang and Peng, 2015; Alp and Franz-Joseph vonWerssowetz, 2013; Tillmann et al., 2012), while other researchers suggest that integration promotes a collaborative culture and equitable relationships throughout the different phases of a project’s life cycle (Ibrahim et al., 2013; Pishdad-Bozorgi and Beliveau, 2016b) that are based on trust and joint commitment (Mesa et al., 2016). Poirier et al. (2016) present the view that collaboration is key for successful delivery of a project in the AEC industry, and they characterize it as an evolving process, not as an endpoint, that changes processes, team dynamics, and behavior (Kenig et al., 2010). Macomber (2004) points to “collaborate, really collaborate” as one of Sutter Health’s five big ideas that form the basis of their Lean project delivery system. Moreover, Lloyd-Walker et al. (2014), Fischer et al., (2014), and Pasquire (2012) describe IPD as being characterized by deep levels of collaboration that allow clarity of scope, better understanding of potential difficulties and uncertainties through the collection of rapid feedback, identification of project constraints, and clarity of roles.

As collaboration is spread among project participants, it becomes a behavioral norm that individuals carry from project to project (Sparkling et al., 2016). Primary stakeholders are engaged in intimate and open collaboration where ambiguity and uncertainty are reduced (Walker et al., 2016; Sarkar and Mangrola, 2016). One of the main objectives in IPD is building a no-blame culture that allows for better coordination and decision-making (Mesa et al., 2016; Do et al., 2015; Dainty et al., 2001a). Through collaboration, knowledge evolves, and learning happens (Poirier et al., 2016). Particularly in IPD projects, fostering
collaborative teams is a must or a primary goal among organizations because collaboration can directly address the problem of fragmentation (Paik et al., 2017; Sarkar and Mangrola, 2016). If team members can gain a better understanding of the project scope, significant rework can be reduced or eliminated; information transfer, knowledge creation, and technological coordination can occur, and resource allocation will improve so that unnecessary conflicts are reduced (Ballard et al., 2012; Love et al., 2015; Liu et al., 2016; Thomsen et al., 2010; Sperling, 2014). IPD builds a more durable and pervasive relationship between stakeholders while maintaining some level of flexibility and a high level of adaptability for when changes occur (Kvan, 2000, p. 411; AIA, 2007; Baiden et al., 2003); however, such collaborative projects also need to adopt organizational structures that support the integration of resources, capabilities, stakeholders, and community and environmental groups (Chen and Manley, 2014; Chan et al., 2010; Lahdenperä, 2012). By working as a single integrated team, stakeholders can potentially explore different perspectives and search for solutions while creating a highly collaborative cross-team environment in which ideas, information, and knowledge are openly shared to build intimate and genuine collaboration that leads to better project performance (Walker et al., 2016; Cohen, 2010; Mossman et al., 2011; Kokkonen and Vaagaasar, 2017; Gray, 1998; Liu and Bates, 2013). Davis (2006) and Walker and Lloyd-Walker (2015) have developed studies in which collaboration is pivotal in building trust, which in turn is fundamental to IPD (Pishdad-Bozorgi and Beliveau, 2016a). Working on tacit knowledge sharing is important to improve team collaboration in construction projects (Zhang and He, 2015; An and Ahmad, 2010; Rezgui et al., 2010; Chinowsky et al., 2011). As Manley and Chen (2017) suggest, the degree of collaboration required in a project is directly related to the degree of uncertainty that exists. The objective in IPD projects is not only to “play nice” but also to develop plans in collaboration with those who will do the work in order to achieve a change that will improve the way work is done as well as implement mechanisms of sharing to foster future collaboration (Zimina et al., 2012; Ballard et al., 2009; Hickethier et al., 2013; Lingard et al., 2014). Through collaboration, project-first or team-first attitudes are fostered in IPD teams (Cheng et al., 2016; Bilbo et al., 2015).
2.4.3.2 Integration as Alignment

Baiden et al. (2006) highlighted alignment as a requirement for achieving full integration and such alignment must consider the drivers for team members’ behaviors, the sources of motivation, and the setting for mutually agreed goals. Integration involves the collaborative ranking of priorities with the ultimate goal of delivering high-performing buildings constructed based on stakeholder definitions of why and how a project will be accomplished (Mah et al., 2016). Integration is seen as the alignment of expectations, interests, and objectives and is achieved through the setting of shared goals and joint commitment to them (Walker et al., 2002). In order to achieve effective team integration, cultural alignment is also required (Kim and Dossick, 2011). Aligned teams are more likely to deal with uncertainty and ambiguity successfully due to the team members’ deep understanding of the project’s situation, context, and limitations (Walker et al., 2016). Through integration, the team can look to improve performance by aligning themselves with the supply chain members’ interests and objectives in a context where the organizational structure plays a key role (Mesa et al., 2016; Bennett and Jayes, 1995; Hamzeh et al., 2009; Ballard et al., 2007).

Other researchers have suggested that through integration, teams are better able to define the responsibilities of individual parties and align participants roles to achieve better project outcomes since the incentives and goals of the project’s participants would be centered on what it best for the project (Sarkar and Mangroala, 2016; Kenig et al., 2010; AIA, 2007; Ballard et al., 2012; Demirkesen and Ozorhon, 2017; Do et al., 2015; Matthews and Howell, 2005; Lichtig, 2005b; Thomsen, et al., 2010; Darrington and Lichtig, 2010; Bilbo et al., 2015; The Construction Users Roundtable, 2004; Aapaoja et al., 2013; Kent and Becerik-Gerber 2010). Ongoing commitment to the shared goals is also important for the alignment of organizational goals for project success; this includes the assemblage of a team whose members are capable of and willing to work together effectively (AIA, 2007; Zhang et al., 2015; Suttie, 2013). Mossman et al. (2010), Mossman et al. (2011), Thomsen et al., (2010) and Aapaoja et al. (2012) have also pointed out that IPD builds cooperation in the pursuit of a shared goal while considering all key players as equals in a single integrated team to build mutual understanding, respect, and foster long-term relations in the pursuit of building a desired organizational culture suitable for integration. Such
Integrated teams work together on jointly develop project targets, making decisions, and looking for consensus (Azhar et al., 2014; Love and Gunasekaran 1998). Specifically, when referring to the alignment of interests and goals, some researchers (Colvin and Boswell, 2007; Gottschalg and Zollo, 2007; Locke and Latham, 1990) define alignment as the degree to which the members of an organization are motivated to behave as a single team with regard to their strategies and goals, and through alignment, individual and team goals become associated and connected. Projects are driven by the shared common goal of doing what is best for the project itself, and individual success relies on the project’s success and the creation and pursuit of a shared vision through integrated governance (Pishdad-Bozorgi et al., 2016; Zhang and Li, 2014; Dossick et al., 2013; Mossman et al., 2010; Alarcon et al., 2013; Tillmann et al., 2012; Tatum, 2012; Franz et al., 2017; Pasquire, 2012).

### 2.4.3.3 Integration as Communication

Macomber and Howell (2004) suggest the two great wastes in organizations are people not speaking up and people not listening to others, both of which are communication problems. Paik et al. (2017) and Liu and Bates (2013) argue that in integrated projects, communication is positively evaluated as one of the most important factors influencing the integration and affects whether an environment where information is openly shared can be cultivated. Other researchers (Rahim et al., 2016; Che Ibrahim et al., 2013; Hauck et al., 2004; Walker et al., 2002) have stated that improvement in communication and relationships is needed in order to achieve integration at all levels of a multidisciplinary team. Sun et al. (2015) have highlighted how integration in IPD involves intensive team communication and interaction within a group of people. Communication has been highlighted as the most influential driver for project performance with regard to cost, schedule, and quality (Mesa et al., 2016). The organizational structure of IPD projects is expected to affect communication positively and foster integrated communication between individuals belonging to different teams (Mesa et al., 2016; Kenig et al., 2010; Garcia et al., 2016; Garcia et al., 2014; Parrish et al., 2008), therefore, avoiding issues related to responsibility distribution (Poole, 2011) as tasks and expectations are not well properly defined causing interferences or missing pieces of information. Different studies support
the assertion that integration is fostered by clearly communicating mutual goals and objectives (Sparkling et al., 2016; Hughes et al., 2012) and the idea that team performance is greatly influenced by open, direct, and honest communication (AIA, 2007). In highly complex projects, teams need a way to communicate reliably and efficiently to create integrated teams that can then work successfully by sharing information, transparently keeping track of performance, and being deeply knowledgeable about the inputs and outputs of their processes (Fischer et al., 2014; Garcia et al., 2014). Aapaoja et al. (2012) have pointed out that communication is required to increase commitment to IPD. Finally, Macomber and Howell (2013) state that the ability to make reliable promises also intrinsically involves communicating requests clearly and committing to them.

2.4.3.4 **Integration as Pain/Gain Sharing**

Integration in IPD through the lens of pain/gain sharing involves a win-win scenario where stakeholders from the main pool of project participants collectively manage and appropriately share the project’s risks and rewards and incentivize collaboration to potentially improve project performance through the collaborative behavior of pursuing common target goals (Fischer et al., 2017; Thomsen et al., 2006; Mesa et al., 2016; Liu et al., 2016; Chan et al., 2004; Sarkar and Mangrola, 2016; Kenig et al., 2010; Thomsen et al., 2010; Kent and Becerik-Gerber, 2010; Azhar et al., 2014; Alp and Franz-Joseph vonWerssowetz, 2013). If there is no economic sharing involved, others will have little or no incentive to adopt changes. The AIA (2007), Hall, (2017) and Zhang and He (2015) have highlighted collective risk management in which the success of individual teams depends on the success of the entire project as one of the requirements for successful IPD use among parties. Matthews and Howell (2005) have also pointed out that sharing within the context of IPS ideally builds an organizational structure where team members all work together with a focus on achieving shared goals: They are like “a group of mountain climbers roped together, if one falls, they all fall”.

Integrated projects embrace risk sharing and adopt strategies and tools such as workshops (Hauck et al., 2004; Love et al., 2010; Tillmann et al., 2012) and target value design (Darrington and Lichtig, 2010; Love et al., 2011; Zimina et al., 2012), which includes in its development certain pain-and-gain mechanism. Participation in a risk and reward pool
is a motivational factor for all parties involved when they share the same pool (Hanks, 2015). However, there is a natural reluctance to participate from members who are not a part of the pain/gain sharing pool, so the project team needs to develop mechanisms to engage everyone in the process and increase commitment to the IPD team (Pishdad-Bozorgi and Beliveau, 2016a) since more and more clients are demanding greater levels of integration in the project delivery method (Christiansen, 2009).

2.4.3.5 Integration as Continuous Improvement

Levitt (2007) has highlighted innovation as the first driver of integration, which implies that there is a network where organizations are collectively learning from each other over multiple projects. Although with traditional delivery methods there is little interest in learning and passing knowledge from project to project, with IPD, teams are constantly seeking to add value to a project through continuous improvement and by collecting and sharing information on lessons learned (Mesa et al., 2016; Thomsen et al., 2010; Fischer et al., 2014; Lichtig, 2006; Che Ibrahim et al., 2013). IPD requires significant rethinking (Cheng et al., 2012), and learning from experience is the basis of continuous improvement. However, Hill et al. (2007) argue that learning through reflection and conversation is still not a habit in many organizations. It is important for the success of a project to integrate relevant knowledge, expertise, and skills throughout the project network (Liu et al., 2016; Zhang and He, 2015). Ballard et al. (2007) studied and presented an interpretation of the 14 principles of the Toyota Way, which focus on the company becoming “a learning organization through relentless reflection and continuous improvement.” In other words, Toyota values reflecting on what has happened, analyzing issues, identifying root causes, and preventing reoccurrence at all levels in order to improve itself. Manley and Chen (2017) suggest that large and complex projects require more intensive learning activities. Moreover, Seed (2014) has pointed out that learning requires a “safe zone in which participants can openly speak” their thoughts and feel free to fail.

2.4.3.6 Integration Understanding in the Research

Integration is defined as a mix or combination of the five different themes presented above. The analysis indicated the emphasis on collaboration and alignment. In terms of
collaboration, the focus is on eliminating or minimizing team fragmentation while building a team-first culture. Furthermore, the implications of integration in terms of alignment covered the unification of goals due to certain implications of sharing values and thoughts. Also, integration is seen as communication due to the reinforced idea of information flow. As pain/gain sharing, integration is seen as a mechanism for making all parties work together for the best of the project since the improvement of project performance means a betterment in their own side. Lastly, integration as continuous improvement is focused on the ideal of moving forward and making changes for the best of project as needed.

Table 2.2 Understanding of Integration in the IPD context

<table>
<thead>
<tr>
<th>Integration Definition</th>
<th>Summary of Current Understanding</th>
<th>Authors supporting the same idea</th>
</tr>
</thead>
</table>
| Collaboration          | Integration is based upon collaboration of project participants in an environment of equitable relationships ending traditional fragmentation. IPD projects are characterized for having high levels of collaboration that brings clarity of the scope, speed up flow of information, and foster knowledge sharing and learning while building team-first behaviors. | Paik et al., 2017; Manley and Chen, 2017; Kokkonen and Vaagaasar, 2017; Teng et al., 2017; Fakhimi et al., 2016; Rahim et al., 2016; Pishdad-Bozorgi and Beliveau, 2016a; Sparkling et al., 2016; Walker et al., 2016; Sarkar and Mangrola, 2016; Pishdad-Bozorgi and Beliveau, 2016b; Cheng et al., 2016; Mesa et al., 2016; Poirier et al., 2016; Liu et al., 2016; Walker and Lloyd-Walker, 2015; Zhang and He, 2015; Zhang et al., 2015; Zhang and Peng, 2015; Do et al., 2015; Bilbo et al., 2015; Love et al., 2015; Lloyd-Walker et al., 2014; Fischer et al., 2014; Chen and Manley, 2014; Sperling, 2014; Alp and Franz-Joseph vonWerssowetz, 2013; Liu and Bates, 2013; Ibrahim et al., 2013; Hickethier et al., 2013; Cheng et al., 2012; Lahdenperä, 2012; Ballard et al., 2012; Zimina et al., 2012; Mossman et al., 2011; Chinowsky et al., 2011; Kenig et al., 2010; Thomsen et al., 2010; Chan et al., 2010; Cohen, 2010; An and Ahmad, 2010; Rezgui et al., 2010;
<table>
<thead>
<tr>
<th>Integration Definition</th>
<th>Summary of Current Understanding</th>
<th>Authors supporting the same idea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AIA, 2007; Davis, 2006; Macomber, 2004; Kvan, 2000; Gray, 1998; Ballard et al, 2009</td>
</tr>
<tr>
<td>Alignment</td>
<td>Alignment is a requirement for achieving integration throughout the supply chain through mutually discussing expectations, and setting goals, objectives, and defining means to achieve them. Aligned teams acquire a very deep understanding of the project, its context, and limitations. Individuals are motivated to behave in the pursuit of a shared goal for achieving the best of the project.</td>
<td>Franz et al., 2017; Paik et al., 2017; Demirkesen and Ozorhon, 2017; Mesa et al., 2016; Walker et al., 2016; Liu et al., 2016; Mah et al., 2016; Pishdad-Bozorgi et al., 2016; Garcia et al., 2016; Sarkar and Mangrola, 2016; Do et al., 2015; Bilbo et al., 2015; Zhang et al., 2015; Azhar et al., 2014; Zhang and Li, 2014; Dossick et al., 2013; Aapaoja et al., 2013; Mollaoglu-Korkmaz, 2013; Suttie, 2013; Alarcon et al., 2013; Tillmann et al., 2012; Tatum, 2012; Ballard et al., 2012; Mossman et al., 2011; Kenig et al., 2010; Thomsen et al., 2010; Kent and Beccerik-Gerber 2010; Mossman et al., 2010; Darrington and Lichtig, 2010; Hamzeh et al., 2009; Thomsen, et al., 2009; AIA, 2007; Colvin and Boswell, 2007; Gottschalg and Zollo, 2007; Ballard et al., 2007; Baiden et al., 2006; Matthews and Howell, 2005; Lichtig, 2005b; Construction Users Roundtable, 2004; Bennett and Jayes, 1995; Locke and Latham, 1990</td>
</tr>
<tr>
<td>Communication</td>
<td>Communication is one of the most important factors that influence integration and build an environment suitable for openly sharing ideas. Multidisciplinary teams foster integration by properly communicating</td>
<td>Paik et al., 2017; Rahim et al., 2016; Sparkling et al., 2016; Garcia et al., 2016; Mesa et al., 2016; Sun et al., 2015; Garcia et al., 2014; Fischer et al., 2014; Liu and Bates, 2013; Che Ibrahim et al., 2013; Macomber and Howell, 2013; Hughes et al., 2012; Aapaoja et al., 2012; Poole, 2011; Kenig et al., 2010; Parrish et al., 2008;</td>
</tr>
<tr>
<td>Integration Definition</td>
<td>Summary of Current Understanding</td>
<td>Authors supporting the same idea</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>mutual goals and objectives.</td>
<td>AIA, 2007; Macomber and Howell, 2004; Hauck et al., 2004; Walker et al., 2002</td>
</tr>
<tr>
<td>Sharing Risk and Reward</td>
<td>Sharing risk and reward in IPDs create a win-win scenario where team members pursue project targets and collectively manage and share pains and gains.</td>
<td>Hall, 2017; Fischer et al., 2017; Pishdad-Bozorgi and Beliveau, 2016a; Zhang and He, 2015; Mesa et al., 2016; Liu et al., 2016; Sarkar and Mangrola, 2016; Hanks, 2015; Azhar et al., 2014; Alp and Franz-Joseph vonWerssowetz, 2013; Zimina et al., 2012; Love et al., 2011; Kenig et al., 2010; Thomsen et al., 2010; Kent and Becerik-Gerber, 2010; Love et al., 2010; Darrington and Lichtig, 2010; Christiansen, 2009; Thomsen et al., 2009; AIA, 2007; Matthews and Howell, 2005; Chan et al., 2004; Hauck et al., 2004</td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>Continuous learning is valuable in IPD teams because of the constant desire to add value to the project and the availability of a safe zone where participants can speak up and share knowledge.</td>
<td>Manley and Chen, 2017; Mesa et al., 2016; Liu et al., 2016; Zhang and He, 2015; Fischer et al., 2014; Che Ibrahim et al., 2013; Cheng et al., 2012; Thomsen et al., 2010; Levitt, 2007; Hill et al., 2007; Ballard et al., 2007; Lichtig, 2006</td>
</tr>
</tbody>
</table>

The level of analysis in the integration research is studied to document what type of interactions were emphasized for integration and a summary of the number of sources that refer or support the definition of integration in one or more of the five themes is included in Table 2.3 and represented in Figure 2.6 below. The analysis suggested that the level of analysis was more focused on collaboration and alignment than on the other categories, but there remains a high incidence in all categories.
Table 2.3 Understanding of Integration in the IPD context

<table>
<thead>
<tr>
<th>Integration Definition</th>
<th>Authors supporting the same idea (n=144)</th>
<th>Authors supporting the same idea (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>48</td>
<td>33 %</td>
</tr>
<tr>
<td>Alignment</td>
<td>41</td>
<td>29 %</td>
</tr>
<tr>
<td>Communication</td>
<td>20</td>
<td>15 %</td>
</tr>
<tr>
<td>Sharing Risk and Reward</td>
<td>23</td>
<td>17 %</td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>12</td>
<td>12 %</td>
</tr>
<tr>
<td>TOTAL</td>
<td>144</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Figure 2.6 Representation of the Understanding of Integration in the Body of Knowledge

2.5 Comparison of Delivery Systems

Different researchers have compared project delivery systems by analyzing specific metrics. Traditional delivery systems such as DB and DBB and how they affect the delivery of a given project have been discussed by Nawi et al. (2014a). Ibbs et al. (2003) compared DB and DBB projects in terms of cost, schedule, and productivity as the performance metrics. El Asmar et al. (2015) have used the project quarterback rating index (PQR), which combines key performance metrics into a single number to more easily compare the most common delivery systems, and their findings confirmed the superiority of IPD over
the other methods. The PQR index used by El Asmar et al. (2015) accounted for analyzing seven performance areas which includes customer relations, safety, schedule, cost, quality, financial metrics, and communication and collaboration. Each of the seven categories were weighted according to their level of importance, subcategories were included and the sum of all define the PQR rate per delivery system. The PQR index developed by El Asmar et al. (2015) showed that IPD outperformed other traditional delivery methods (see Fig. 2.7).

![Figure 2.7 Overall Project Performance for Major Project Delivery Systems (El Asmar et al., 2015)](image)

The author summarized the findings from the systematic literature review on the differences between traditional delivery methods and IPD in terms of different categories (see Table 2.4).
Table 2.4 Comparison Between Traditional Delivery Versus IPD Approach

<table>
<thead>
<tr>
<th>Traditional Delivery Methods</th>
<th>IPD Delivery Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hierarchical; reducing price on bidding phase and generate later change orders</td>
<td>Organization</td>
<td>Value generation; defining scope of work and pricing accordingly; reducing price by team work; leadership</td>
</tr>
<tr>
<td>Goals are not aligned; blame</td>
<td>Culture</td>
<td>Goals aligned to clients’ objectives; embrace innovation; learning from mistakes; challenge paradigms; trust and honesty</td>
</tr>
<tr>
<td>Individual thinking; unilateral effort</td>
<td>Thinking</td>
<td>Collaborative; looking for solutions as a team</td>
</tr>
<tr>
<td>Silos; assembled on minimum necessary basis; individual capabilities; fragmented; constructor usually involve late in the process</td>
<td>Team</td>
<td>Collaborative and integrated team; committed to deliver value; high performing teams; encourage; co-located; team success for project success; right people</td>
</tr>
<tr>
<td>Traditional Delivery Methods</td>
<td>IPD Delivery Method</td>
<td>Reference</td>
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<tr>
<td>------------------------------</td>
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</tr>
<tr>
<td>at the right time; consider everyone opinions</td>
<td>Leadership: Direction is dictated collaboratively by the whole team</td>
<td>Do et al., 2015; Kog and Loh, 2012; Demirkesen and Ozorhon, 2017</td>
</tr>
<tr>
<td>Dictated by few people; defines the project direction</td>
<td>Knowledge: Shared; lessons learned; environment of learning; continuous improvement; concurrent and multidisciplinary</td>
<td>Walker et al., 2016; Mossman et al., 2010; Zhang and He, 2015; Zhang and Ng, 2013; Solis et al., 2013</td>
</tr>
<tr>
<td>Silos; repetitive mistakes; rework</td>
<td>Communication: Flow; early involvement of key participants; speak up</td>
<td>Khanzode et al., 2006; Mossman et al., 2011; Bal et al., 2013; Hanna, 2016; El Asmar et al., 2013; Molenaar et al., 2009; Bosher et al., 2007; Kenig et al., 2010; Korkmaz et al., 2010</td>
</tr>
<tr>
<td>Lack of information</td>
<td>Shared Governance: Decision-Making: Systematic; tools such A3, CBA, 5 whys; clusters and core teams are empowered to decide on certain scope for the best for project</td>
<td>Chen and Manley, 2014; Hauck et al., 2004; Love et al., 2015; Hall, 2017; Kenig et al., 2010; Yukl, 2012; Sun et al., 2015</td>
</tr>
<tr>
<td>Individual; not linked with the team’s goals; divided</td>
<td>Shared Governance: Risk &amp; Reward: Collectively managed; tied to project success</td>
<td>Chen and Manley, 2014; Walker et al., 2016; and Matthews and Howell, 2005</td>
</tr>
<tr>
<td>Traditional Delivery Methods</td>
<td>IPD Delivery Method</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------------</td>
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<td>-----------</td>
</tr>
<tr>
<td>individual managed</td>
<td></td>
<td>Teng et al., 2017; Pishdah-Bozorgi et al., 2016; Schroeder, 2014; Zhang and Li, 2014</td>
</tr>
<tr>
<td>Optimize parts; linear and segregated</td>
<td>Processes</td>
<td>Optimize the whole; flexible</td>
</tr>
<tr>
<td>Not much use</td>
<td>Technology</td>
<td>Digitally based; accurate designs; encourage collaborative work</td>
</tr>
<tr>
<td>Not accurate; partitioned by trades and disciplines</td>
<td>Planning</td>
<td>Pull planning; last planners involvement; constraints analysis</td>
</tr>
<tr>
<td>Inflexible; autocratic; fixed processes</td>
<td>Control</td>
<td>Network of commitments; processes and measures are integrated</td>
</tr>
<tr>
<td>Architect tend to work in isolation</td>
<td>Project Definition and Design</td>
<td>Collaboration of AEC members plus key trade partners</td>
</tr>
<tr>
<td>Transactional contracts</td>
<td>Agreement</td>
<td>Relational contracts</td>
</tr>
</tbody>
</table>
2.6 Benefits of Implementing IPD in Practice

Since IPD has gained popularity and recognition over the years, it would be beneficial to identify the current state of practice in the Peruvian construction industry and understand any key factor of success. A wide range of forces that could potentially instigate significant changes in the design and construction industry have essentially remained unchanged for well over a century (Kenig et al., 2010). It is a common practice when thinking about driving forces to categorize them into specific schemes. Some researchers have used the following categories: economic, social, and moral (Levitt and Dubner, 2005) to divide the benefits. From an economic perspective, IPD has exhibited money-saving potential for the project owner and other parties involved during the design and construction phases and more recently in the operation and maintenance phases of a facility as well. Integrated processes have shown the potential to reduce delays and the waste of transport, material, labor, and money since they are driven by collaboration and teamwork (Ballard and Howell, 2005; Lichtig, 2005b; Matthews and Howell, 2005).

When thinking about the social aspects, IPD aims to help build trust and commitment between team members. Because the construction industry in Peru has operated largely on mistrust between parties (Medina 2014), the need for a different approach is emphasized to address issues related to this mistrust and begin creating mutual respect to foster a positive environment. Why pursue collaboration? As Dean Reed suggested during his presentation in the National Lean Construction Congress in Lima, Peru (2017): “Because it works, and because we can”. The industry has been too slow in adopting new collaborative approaches. Prior to IPD, stakeholders worked independently to optimize their own benefits with no care of their impact on others; some even created separate warring factions that looked for their own benefit at another’s expense. This behavior is the natural consequence of commercial terms that have different companies paying them for the completion of their specific scope of work as opposed to having their pay linked to the achievement of project objectives.

In a similar way, when considering the moral or social aspect (O’Connor 2009), IPD can be said to encourage a collaborative environment that reinforces teamwork through moral and social incentives. Mossman et al. (2010) say some of the motivations for clients to embrace IPD are the potential to obtain more value and reduce operation and maintenance
costs of use; for designers, motivations can be the potential reduction of design documentation time as well as the aim to keep the design within the target cost, and for contractors, motivations could be the aim for less rework and more buildable facilities. Mossman et al. (2010) also categorized the main benefits of using IPD according to the stakeholder. Through IPD, clients i) receive higher value, ii) see a reduction in life cycle costs, and iii) enjoy faster delivery and higher quality. Meanwhile, designers i) enjoy less rework, ii) are able to design to target cost, iii) have improved abilities to identify the client’s needs, iv) can make decisions at the last responsible moment, and v) are actively involved in the construction process. Finally, contractors i) see less rework, ii) gain a faster understanding of project scope, iii) improve their relationships, iv) can use more reliable drawings and processes, v) reduce variability – that results in fewer changes, and vi) achieve more buildable projects.

However, in studying these different benefits, the author divided them into three different levels of impact: the individual level, team level, and organizational level. Past studies have discussed the potential benefits of integrated delivery and highlighted a handful of successful IPD cases (AIA, 2012; Mossman et al., 2010). The list of benefits in this section was developed based on the extensive literature review. A total of 36 categories were found under the code of benefits and those were divided into individual (9), team (15) and organizational (12) level according to the impact of such benefit. Besides the categories in which the benefits can be divided, it is important to highlight that IPD has also proved its success by positively impacting construction projects. Based on the findings of the literature review, there is strong evidence that support the superior performance of IPD among other methods. As an example, Mossman et al. (2011 pg.1) explained in a study published in the Construction Research and Innovation journal, IPD has already exhibited some level of success in construction: “Projects in the US and UK that used Integrated Project Delivery (IPD) with Target Value Design (TVD) were brought in as much as 19 percent below market cost and expected costs actually fell as design and construction progressed”.
2.6.1 Individual Level Benefits

Benefits at the individual level aim to encourage individuals to embrace the change and are summarized under 9 categories listed below:

- Great learning opportunity (Lostuvali et al., 2014; Nanda et al., 2016).
- Collaborative practices build durable relationships since “individuals and teams are afforded stronger relationships” (Sparkling et al., 2016).
- Allows a close analysis about how people work and increase understanding of other disciplines (Do et al., 2015; Suttie, 2013) while allow the team to get familiar with the project scope and design (Kent and Becerik-Gerber 2010).
- Allows understanding everyone’s perspectives (Do et al., 2015).
- Increase employees’ satisfaction and empowerment while having a balanced life within work, enjoyment and fun (Do et al., 2015; Suttie, 2013; Kenig et al., 2010; Cheng et al., 2016; Salem et al., 2005).
- Feel pride for delivering better quality projects and more enjoyable places to work (Kent and Becerik-Gerber 2010).
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- Improve individual commitments and conversations where decisions are taken at the last responsible moment (Mossman et al., 2010; Mossman et al., 2011).
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2.6.2 Team Level Benefits

As individuals start observing the benefits of applying IPD in their projects, teams would be able to visualize the following benefits at a team level:

- Increase predictability of cost and schedule through value engineering and designing to targets (Cheng et al., 2012; Mossman et al., 2010; Mossman et al., 2011; Do et al., 2015; Zimina et al., 2012; Collins and Parrish, 2014; Ghassemi and
Becerik-Gerber, 2011; Kim et al., 2016) and deliver better project outcomes which is translated in projects with greater quality and safety being completed under the promised targeted schedule and cost (Fernandez-Solis et al., 2013; Cohen, 2010; Korkmaz et al., 2010; Cheng et al., 2012; Ghassemi and Becerik-Gerber, 2011; Do et al., 2015; Thomsen et al., 2010; Cheng et al., 2016; Sperling, 2014; Demirkesen and Ozorhon, 2017; Kim et al., 2016; El Asmar et al., 2016; Fakhimi et al., 2016; El Asmar et al., 2013; Che Ibrahim et al., 2013; Seed, 2014).

- Improve supply chain integration by removing team fragmentation (Mesa et al., 2016; Fernandez-Solis et al., 2013; Thomsen et al., 2010).

- Increase levels of trust (Do et al., 2015; Lostuvali et al., 2014; Mesa et al., 2016) and create ownership of key players since there is an increase of downstream parties getting involved early in the project and work upstream augmenting accuraness and accountability (Cohen, 2010; Thomsen et al., 2010; Sperling, 2014; Pishdad-Bozorgi and Beliveau, 2016b) in projects where architects get to spend more time on site and the contractor and other parties participate in the design phase.

- Design process is more collaboratively, design is more buildable, and more effort is put in constructability (Mossman et al., 2010; Mossman et al., 2011; Ballard, 2008; Do et al., 2015; Sparkling et al., 2016).

- Reduce documentation time and approvals (AIA, 2007; Do et al., 2015; Mossman et al., 2010).

- Superior communication and information and knowledge exchange with a variety of voices on the table (Fernandez-Solis et al., 2013; Hanna, 2016; Cheng et al., 2016; Demirkesen and Ozorhon, 2017; Rahim et al., 2016; Kim et al., 2016; El Asmar et al., 2015; Fakhimi et al., 2016; El Asmar et al., 2013; Suttie, 2013; Lostuvali et al., 2012; Franz et al., 2017; Kim et al., 2016), alignment of interests, objectives, and cultures (Kenig et al., 2010; Pishdad-Bozorgi and Beliveau, 2016b; Kim et al., 2016).

- Identify problems early and solve them as a cohesive team (Kenig et al., 2010) and improve also the speed to solve issues through the use of standard problem-solving processes including its later documentation and sharing of lessons learned (Do et al., 2015; Cheng et al., 2016).
• Timely and informed understanding of the design and reduce errors between trades (AIA, 2007).
• Allow anticipated detection and solution of potential design conflicts, deliver more accurate design, and avoid later disputes (Kenig et al., 2010; AIA, 2007; Sperling, 2014; Kim et al., 2016; Sparkling et al., 2016).
• Making processes more transparent sharing actual performance and forecasts (Do et al., 2015).
• Increase time devoted on planning during pre-construction phase (Cheng et al., 2012; AIA, 2007; Pishdad-Bozorgi and Beliveau, 2016b).
• Increase flow reliability and reduce firefighting of daily problems (Fernandez-Solis et al., 2013; Forero et al., 2015) while having less rework in construction and design phase (Mossman et al., 2010; Mossman et al., 2011; Do et al., 2015; Forero et al., 2015; El Asmar et al., 2013; Kulkarni et al., 2012; Lostuvali et al., 2012) and consequently eliminating waste (Kenig et al., 2010; Sperling, 2014; El Asmar et al., 2013; Kent and Becerik-Gerber, 2010).
• Reduce ambiguities (Walker et al., 2016), eliminate hidden contingencies (Cheng et al., 2012; Do et al., 2015; Thomsen et al., 2010; Mesa et al., 2016), and improve risk management through sharing risk and reward mechanisms and predictable workflow (Cheng et al., 2012; Do et al., 2015; Pishdad-Bozorgi et al., 2016; Alarcon et al., 2013; Kent and Becerik-Gerber, 2010).
• Reduce number of RFIs and RFI processing time (Hanna, 2016; Do et al., 2015; Bilbo et al., 2015; El Asmar et al., 2013; Kent and Becerik-Gerber, 2010), number of change orders and the time for processing them (Do et al., 2015; Collins and Parrish, 2014; Kenig et al., 2010; Kim et al., 2016; Hanna, 2016; Fakhimi et al., 2016; Bilbo et al., 2015; Kent and Becerik-Gerber, 2010; El Asmar et al., 2013; Kulkarni et al., 2012; Nanda et al., 2016; Kent and Becerik-Gerber, 2010), and number of elements in the punchlist for turnover (El Asmar et al., 2013; Franz et al., 2017).
• Foster retrospective and constant reflection to facilitate people think about why specific tasks ended up not being as planned (Do et al., 2015; Lichtig 2007).
2.6.3 Organizational Level Benefits

Also, the research aimed to highlight what are the benefits that incentivize organizations moving towards integration. The following list summarized benefits at the organizational level:

- Market advantage through better understanding owner goals and expectations (Cheng et al., 2016; Rahim et al., 2016; Cheng et al., 2012; AIA, 2007; Do et al., 2015) and familiarize with all trades interest and perspectives and engage them with the best for the project ideal to accomplish owner’s business objectives (Cheng et al., 2016; Forero et al., 2015; Lostuvali et al., 2014; Nanda et al., 2016; Heravi et al., 2015).

- Build and constantly enhance company image and reputation potentially assuring repeat businesses (Hanna, 2016; Sparkling et al., 2016; Thomsen et al., 2010; Rahim et al., 2016). 

- Deliver a high-quality facility is a key deliverable in IPD (Kahvandi et al., 2017; Mossman et al., 2010; Mossman et al., 2011; El Asmar et al., 2013; Kim et al., 2016).

- Improve financial benefits such profit margins (Sparkling et al., 2016; Suttie, 2013)

- Search for opportunities of constant improvement such plus/delta sessions, prefabrication (Do et al., 2015; Sperling, 2014; Kent and Becerik-Gerber, 2010).

- Develop a new project culture focus on strong teamwork (Thomsen et al., 2010; Cheng et al., 2016).

- Initial investment pays off with later improvements (Cheng et al., 2016; Mossman et al., 2011).

- Win-win ideal is established (Kim et al., 2016; Sparkling et al., 2016).

- Human resources are used more efficiently (El Asmar et al., 2013).

- Reduce operation and maintenance cost of the facility (Kent and Becerik-Gerber, 2010).

- Build a corporate culture (Sparkling et al., 2016; Thomsen et al., 2010) in which the organizational structure builds trust and respect (Mesa et al., 2016) and greater collaboration within partners of different organizations building a community a
sense of having a great place to work (Fernandez-Solis et al., 2013; Heravi et al., 2015; Sun et al., 2015; Lostuvali et al., 2014)

- Improve resolution of claims and reduce litigation (Sparkling et al., 2016; Kim et al., 2016)

### 2.7 Infrastructure Projects in Peru and Potential Application of IPD

Changali and van Nieuwland (2015) from McKinsey & Company wrote a report called “The Construction Productivity Imperative” in which they projected that global investment in infrastructure projects would double in the next 15 years (see Fig. 2.8). The report used data from public annual reports from various companies that were published in the IHS Herold Global Projects Database, and the researchers estimated that around 98% of megaprojects suffer cost overruns of at least more than 30% the original cost while deviating from the original schedule by falling an average of 20 months behind (see Fig. 2.9).

![Figure 2.8 Projected Infrastructure Investment Projection in the Next 15 Years](image)

During the ’80s and ’90s, Peru suffered an economic crisis that limited investment in infrastructure projects (World Bank, 2017). Consequently, the public construction sector slowed down and traditional delivery methods such as DBB and DB prevailed in the Peruvian market (Medina, 2014). This was similar to the situation in other Latin America countries such Colombia where DBB is also the traditional delivery method of choice (Forero et al., 2015). According to a report from the national institute of statistics and informatics from Peru (2016), today, the Peruvian economy is growing constantly with an average steady growth in the construction sector of 9.7% per year in the last decade. However, the construction industry has been slow to respond to changes and continues to uphold traditional processes that are characterized by the same slow, tedious processes and practices linked to traditional approaches. This has been occurring despite the fact that the need for investment in infrastructure projects is very high, so there is a need for a change in practices to better respond to the current climate in the industry.
For example, more than 25% of people in the Peruvian population do not have access to drinkable water. Furthermore, as shown in Figure 2.10, there is a need for further investment in building projects for the transportation, healthcare, energy, telecommunications, and education sectors, with an estimated cost of up to $1.6 billion (USD) to meet those needs (Bonifaz et al., 2015). As a result, efficiency in the construction sector is of critical importance for the nation since it is this sector that provides infrastructure development.

![Infrastructure Gap in Peru](image)

*Figure 2.10 Infrastructure Gap in Peru (after Bonifaz et al., 2015, "A Plan to Get Out of Poverty: National Infrastructure Plan 2016-2025", AFIN)*

Infrastructure projects involve a wide range of organizations that must work together and deal with large and complex tasks; therefore, a collaborative delivery method is needed due its ability to support people in managing the high levels of complexity and risk involved (Love et al., 2010; Walker et al., 2015; Lahdenperä, 2012). Also, Levitt (2007) points out that infrastructure development requires a different project structure from traditional approaches that can foster integrated project governance such as private-public partnerships, which work reasonably well. The complex nature of infrastructure project construction renders them ideal candidates for implementing an IPD approach.
To better analyze infrastructure projects, different researchers have suggested dividing them into different construction phases. Heinsz et al. (2012) suggested a project be divided into “financial and technical feasibility, conceptual design, detailed design, construction, operations, and renovation/replacement”. Pocock et al. (1996), on the other hand, proposed a project be divided into the phases of “planning, conceptual design, detailed design, procurement, construction, and start-up”. However, the author will adopt the terminology used in the Project Production Laboratory Systems (P2SL) glossary, which divides a project into five phases: project definition, lean design, lean supply, lean assembly, and use of the facility, as seen in Figure 2.11. Each phase overlaps with the next one to some extent (Ballard et al., 2007), and they shall not be considered independent phases but rather a network of commitments in the pursuit of a shared goal.

![Figure 2.11 Lifecycle Phases of Construction Projects (Project Production Systems Laboratory Glossary, UC Berkeley)](image)

### 2.8 Summary

Many authors have characterized the architecture, engineering, and construction (AEC) industry as a highly fragmented sector and this division often results in poor project performance in terms of productivity, safety, and quality (Mesa et al., 2016; Nawi et al., 2014a). Researchers such as Mills (2001), Aapaoja (2013) and Zhang et al. (2013) have described the construction industry as being one of the most dynamic, risky, and challenging industries. Moreover, other researchers such as Demirkesen and Ozorhon (2017) and Nawi et al. (2014a) have highlighted the dynamic, fragmented, and complex nature of construction projects. IPD potential to deal with highly complex projects has made its application in infrastructure projects important to achieve project performance objectives in terms of cost, schedule, quality, safety, sustainability, and work environment. IPD benefit individuals, teams and organizations while helping deliver the highest possible value to clients and establishing durable relations.
3. INTEGRATED PROJECT DELIVERY FRAMEWORK

3.1 Introduction

Integrated project delivery (IPD) has emerged as an alternative approach to traditional methods for delivering value to clients, addressing many of the challenges present in traditional construction projects, and improving overall project performance by aligning stakeholder interests and objectives while integrating people, systems, and practices throughout all phases of a construction project (Aapaoja et al., 2013; Mesa et al., 2016; Mossman et al., 2011; Do et al., 2015; Kim et al., 2016; American Institute of Architects [AIA], 2007; Mah et al., 2016; Matthews and Howell, 2005; Sun et al., 2015; Alp and Franz-Joseph vonWerssowetz, 2013; Ghassemi and Becerik-Gerber 2011; Lichtig, 2006; Bilbo et al., 2015). Instances of IPD projects helping people transition from an individual mindset to a collaborative approach and thus improving team integration have been documented by practitioners and academic researchers (Walker et al., 2016; Cohen, 2010; Forero et al., 2015; Mollaoglu et al., 2013; Azhar et al., 2014), supporting the fact that IPD is not just a utopian vision (Khemlani, 2009). Instead, IPD works when individuals participate in the social exchange framework to make and keep commitments (Mossman et al., 2011; Hellmund et al., 2008), and it relies on heavy trust-based collaboration between all stakeholder (Zhang et al., 2015).

Chang (2014) points out that to address problems more systematically, setting out a framework is useful; therefore, as a result of the systematic literature review, the author developed a conceptual framework for implementing IPD. The conceptual framework also describes the attitudes that will enable IPD implementation and a potential organizational structure for integrated projects. The conceptual model can serve as a guide or framing mechanism for practitioners to explore the applications of IPD principles and tools and consider the expected behaviors that will facilitate IPD implementation by aligning stakeholders’ goals and expectations. This research is complemented by an analysis of trust enablers and barriers and participant expectations regarding IPD. To develop this framework, knowledge of how IPD has been applied by different organizations is analyzed, and for ease of use, the framework has been divided into the following layers:
1. Framework layer 1: The first layer is associated with a set of principles that shall govern an IPD project.

2. Framework layer 2: The second layer addresses the tools that facilitate IPD implementation through the entire life cycle of a project.

3. Framework layer 3: The third layer describes the project governance structure that makes a project suitable for IPD implementation and details the enablers that enhance the desired behaviors for an integrated project.

This framework should be adjusted on a project-by-project basis during implementation to pursue the best value for the project at hand.

### 3.2 Literature Review

#### 3.2.1 IPD for Complex Projects

Integrated Project Delivery (IPD) has emerged as an alternative approach for delivering value to clients, addressing many of the challenges presented in traditional construction, and improving overall project performance by aligning stakeholders interests and objectives while integrating people, systems, and practices through all phases of construction projects (Aapaoja et al., 2013; Mesa et al., 2016; Mossman et al., 2011; Do et al., 2015; Kim et al., 2016; AIA, 2007; Mah et al., 2016; Matthews and Howell, 2005; Sun et al., 2015; Alp and Franz-Joseph vonWerssowetz, 2013; Ghassemi and Becerik-Gerber, 2011; Lichtig, 2006; Bilbo et al., 2015). Instances of IPD projects transitioning from an individual mindset to a collaborative approach improving team integration have been documented by practitioners and academic researchers (Walker et al., 2016; Cohen, 2010; Forero et al., 2015; Mollaoglu et al., 2013; Azhar et al., 2014) supporting the fact that IPD is not just a utopian vision (Khemlani, 2009). IPD works when individuals are in the social exchange framework to make and keep commitments (Mossman et al., 2011; Hellmund et al., 2008) and it relies on highly trust-based collaboration within all stakeholder (Zhang et al., 2015) supported in some case by a relational agreement considered by some authors as the hallmark of IPD (Kenig et al., 2010; Darrington, 2011). The Construction Industry Institute (CII, 1996) called for a cultural change that embrace collaboration in the construction industry. IPD fosters a cultural change towards collaboration (Suttie, 2013)
and it requires a team thinking approach because it aims to create a harmony between different elements that need to fit together, and it needs the buy-in from all players to successfully work (Daswani et al., 2015). Although IPD has primarily been applied to the design and construction phase of projects, the project is shaped and delivered with an eye to the entire lifecycle of the constructed asset (Alp and Franz-Joseph von Werssowetz, 2013; Cohen, 2010; Fish, 2011; Ballard, 2008). Consequently, IPD is a good fit for infrastructure projects delivered in the form of private-public partnership (PPP) due their high complexity. In US construction industry, clients have been leading the change requiring AEC companies to work collaboratively and improve their performance in the delivery of capital projects.

No consensus has been established in the industry as a whole regarding IPD definition (Ibrahim, 2013). However, while consensus on IPD definition remains elusive, it is in process of ongoing development, but many researchers have stated that IPD requires a paradigm shift that supports lean thinking throughout the whole lifecycle of the project (Lichtig 2007; Nanda et al., 2016; Azhar et al., 2014; Naney et al., 2012) and most definitions support this statement. Khanzode et al. (2006) suggested that the lean project delivery system or integrated project delivery system provides a framework to structure the project in a way in which the lean ideal and principles will be better implemented.

Integration is “the sum of many things” (Aapaoja et al., 2013) and particularly in construction, integration considers the complex interactions of project tiers and the variety of disciplines and technical systems that are a part of construction projects (Ibrahim, 2013; Liu et al., 2016). The definition of integration in different disciplines might vary in focus and extent, but in all cases, integration has yielded improvements in project performance and supports the creation of positive, cooperative, and collaborative teamwork (Ibrahim et al., 2013; Latham, 1994; Egan, 2002; Constructing Excellence, 2004).

Baiden et al. (2006) define integration as a state “where different disciplines or organizations with different goals, needs and cultures merge into a single cohesive and mutually supporting unit with collaborative alignment of processes and cultures”. Meanwhile, Lawrence and Lorsch (1967) perceive integration as “the quality of the state of collaboration which exists among departments that are required to achieve unity of effort because of environmental demands”.

IPD aims to build cooperation and involve all members of a team as equals in the pursuit of a shared goal (Mossman, 2010; Fakhimi et al., 2016; Love and Gunasekaran, 1998; Baiden et al., 2003). The concept of integration is not new in the construction industry and it has multiple meanings in IPD; however, there is a consensus between researchers (Demirkesen and Ozorhon, 2017) that integration is key for successful project execution. Integration seeks for individuals with different backgrounds and expertise to learn from one another and solve problems as a team (Lichtig, 2005a).

In an integrated project, the contractor's knowledge of constructability and value engineering can add great value to the project during the design phase; however, contractors are traditionally seen mostly as builders only and thus are often assigned during the execution phase of the project (Heravi et al., 2015). Pishdad-Bozorgi (2017) indicated that the uniqueness and complexity of construction projects foster collaboration and IPD has proven its effectiveness in managing complex, dynamic, and fast projects (Ballard et al., 2011; Bilbo et al., 2015). Moreover, Thomsen et al. (2010) have suggested that integrated project delivery (IPD) is a viable solution to current construction issues associated with traditional delivery systems. Dodge Data and Analytics (2016) developed a study that differentiated typical projects from the best ones in a sample of 162 projects, and the results show that the best projects choose IPD as the preferred method of project delivery over traditional approaches such as construction management at risk, design-build, and design-bid-build.

### 3.2.2 Benefits of Implementing IPD in Practice

Since IPD has gained popularity and recognition over the years, it would be beneficial to identify the current state of practice in the Peruvian construction industry and understand any key factor of success. A wide range of forces that could potentially instigate significant changes in the design and construction industry have essentially remained unchanged for well over a century (Kenig et al., 2010). It is a common practice when thinking about driving forces to categorize them into specific schemes. Some researchers have used the following categories: economic, social, and moral (Levitt and Dubner, 2005) to divide the benefits. From an economic perspective, IPD has exhibited money-saving potential for the project owner and other parties involved during the design and construction phases and
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- Allows understanding everyone’s perspectives (Do et al., 2015).
- Increase employees’ satisfaction and empowerment while having a balanced life within work, enjoyment and fun (Do et al., 2015; Suttie, 2013; Kenig et al., 2010; Cheng et al., 2016; Salem et al., 2005).
- Feel pride for delivering better quality projects and more enjoyable places to work (Kent and Becerik-Gerber 2010).
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- Improve supply chain integration by removing team fragmentation (Mesa et al., 2016; Fernandez-Solis et al., 2013; Thomsen et al., 2010).

- Increase levels of trust (Do et al., 2015; Lostuvali et al., 2014; Mesa et al., 2016) and create ownership of key players since there is an increase of downstream parties getting involved early in the project and work upstream augmenting accuracy and accountability (Cohen, 2010; Thomsen et al., 2010; Sperling, 2014; Pishdad-Bozorgi and Beliveau, 2016b) in projects where architects get to spend more time on site and the contractor and other parties participate in the design phase of the project.
Design process is more collaboratively, design is more buildable, and more effort is put in constructability (Mossman et al., 2010; Mossman et al., 2011; Ballard, 2008; Do et al., 2015; Sparkling et al., 2016).

Reduce documentation time and approvals (AIA, 2007; Do et al., 2015; Mossman et al., 2010).

Superior communication and information and knowledge exchange with a variety of voices on the table (Fernandez-Solis et al., 2013; Hanna, 2016; Cheng et al., 2016; Demirkesen and Ozorhon, 2017; Rahim et al., 2016; Kim et al., 2016; El Asmar et al., 2015; Fakhimi et al., 2016; El Asmar et al., 2013; Suttie, 2013; Lostuvali et al., 2012; Franz et al., 2017; Kim et al., 2016), alignment of interests, objectives, and cultures (Kenig et al., 2010; Pishdad-Bozorgi and Beliveau, 2016b; Kim et al., 2016).

Identify problems early and solve them as a cohesive team (Kenig et al., 2010) and improve also the speed to solve issues through the use of standard problem-solving processes including its later documentation and sharing of lessons learned (Do et al., 2015; Cheng et al., 2016).

Timely and informed understanding of the design and reduce errors between trades (AIA, 2007).

Allow anticipated detection and solution of potential design conflicts, deliver more accurate design, and avoid later disputes (Kenig et al., 2010; AIA, 2007; Sperling, 2014; Kim et al., 2016; Sparkling et al., 2016).

Making processes more transparent sharing actual performance and forecasts (Do et al., 2015).

Increase time devoted on planning during pre-construction phase (Cheng et al., 2012; AIA, 2007; Pishdad-Bozorgi and Beliveau, 2016b).

Increase flow reliability and reduce firefighting of daily problems (Fernandez-Solis et al., 2013; Forero et al., 2015) while having less rework in construction and design phase (Mossman et al., 2010; Mossman et al., 2011; Do et al., 2015; Forero et al., 2015; El Asmar et al., 2013; Kulkarni et al., 2012; Lostuvali et al., 2012) and consequently eliminating waste (Kenig et al., 2010; Sperling, 2014; El Asmar et al., 2013; Kent and Becerik-Gerber, 2010).
• Reduce ambiguities (Walker et al., 2016), eliminate hidden contingencies (Cheng et al., 2012; Do et al., 2015; Thomsen et al., 2010; Mesa et al., 2016), and improve risk management through sharing risk and reward mechanisms and predictable workflow (Cheng et al., 2012; Do et al., 2015; Pishdad-Bozorgi et al., 2016; Alarcon et al., 2013; Kent and Becerik-Gerber, 2010).

• Reduce number of RFIs and RFI processing time (Hanna, 2016; Do et al., 2015; Bilbo et al., 2015; El Asmar et al., 2013; Kent and Becerik-Gerber, 2010), number of change orders and the time for processing them (Do et al., 2015; Collins and Parrish, 2014; Kenig et al., 2010; Kim et al., 2016; Hanna, 2016; Fakhimi et al., 2016; Bilbo et al., 2015; Kent and Becerik-Gerber, 2010; El Asmar et al., 2013; Kulkarni et al., 2012; Nanda et al., 2016; Kent and Becerik-Gerber, 2010), and number of elements in the punchlist for turnover (El Asmar et al., 2013; Franz et al., 2017).

• Foster retrospective and constant reflection to facilitate people think about why specific tasks ended up not being as planned (Do et al., 2015; Lichtig 2007).

3.2.2.3 Organizational Level Benefits

Also, the research aimed to highlighted what are the benefits that incentivize organizations moving towards integration. The following list summarized benefits at the organizational level:

• Market advantage through better understanding owner goals and expectations (Cheng et al., 2016; Rahim et al., 2016; Cheng et al., 2012; AIA, 2007; Do et al., 2015) and familiarize with all trades interest and perspectives and engage them with the best for the project ideal to accomplish owner’s business objectives (Cheng et al., 2016; Forero et al., 2015; Lostuvali et al., 2014; Nanda et al., 2016; Heravi et al., 2015).

• Build and constantly enhance company image and reputation potentially assuring repeat businesses (Hanna, 2016; Sparkling et al., 2016; Thomsen et al., 2010; Rahim et al., 2016).
• Deliver a high-quality facility is a key deliverable in IPD (Kahvandi et al., 2017; Mossman et al., 2010; Mossman et al., 2011; El Asmar et al., 2013; Kim et al., 2016).

• Improve financial benefits such as profit margins (Sparkling et al., 2016; Suttie, 2013).

• Search for opportunities of constant improvement such as plus/delta sessions, prefabrication (Do et al., 2015; Sperling, 2014; Kent and Becerik-Gerber, 2010)

• Develop a new project culture with focus on strong teamwork (Thomsen et al., 2010; Cheng et al., 2016).

• Initial investment pays off with later improvements (Cheng et al., 2016; Mossman et al., 2011).

• Win-win ideal is established (Kim et al., 2016; Sparkling et al., 2016).

• Human resources are used more efficiently (El Asmar et al., 2013).

• Reduce operation and maintenance cost of the facility (Kent and Becerik-Gerber, 2010).

• Build a corporate culture (Sparkling et al., 2016; Thomsen et al., 2010) in which the organizational structure builds trust and respect (Mesa et al., 2016) and greater collaboration within partners of different organizations building a community a sense of having a great place to work (Fernandez-Solis et al., 2013; Heravi et al., 2015; Sun et al., 2015; Lostuvali et al., 2014).

• Improve resolution of claims and reduce litigation (Sparkling et al., 2016; Kim et al., 2016).

3.2.3 Summary State of the Art

The never-ending issue of having projects that often do not meet the owner’s performance requirements (Lichtig, 2006) can be linked to a Construction Users Roundtable (2014) report, which announced that lack of cooperation and poor integration is one of the root causes for most cost and schedule overruns. In addition, Mitropoulos and Tatum (2000) found that the degree of project integration directly affects project performance outcomes. Although construction projects might appear to be similar in scope, they are unique not only due to differences in scope but also because of surrounding contexts (Ghassemi and
Becerik-Gerber, 2011; Pishdad-Bozorgi, 2017), and therefore projects are full of uncertainties (Liu, 2013). To reiterate, construction projects are often seen as complex (Franz et al., 2017; Do et al., 2015; Palacios et al., 2011). This is particularly true in the case of building infrastructure projects due to the numerous organizations working together on a given project and the collective relationships that are formed between individuals with different backgrounds, beliefs, and expectations. According to Wood and Gidado (2008), the process of designing, constructing, and operating facilities along with the interactions that occur between the stages is particularly complex. Such projects are also characterized by complex decision-making processes, multistakeholder involvement to deal with the high level of risk, and the uncertainty and ambiguity that comes with these additional considerations (Walker et al., 2016). As a result, the owners of complex projects, general contractors, and architects are all exploring the use of collaborative practices to improve project performance (Khanzode et al., 2005; Reed et al., 2006).

IPD implies a transformational change in the behavior of the project participants and the means and methods they use. It aims to break down the traditional silos of construction and improve collaboration, communication, and alignment between different stakeholders in a project. Because infrastructure projects are often more complex than other projects, integration in project delivery is even more necessary. Even though integration might seem to be a natural requirement for success in multidisciplinary industries such as construction, resistance to change and negative attitudes towards new systems such as IPD remains prevalent mainly due to the lack of knowledge on and understanding of the subject or due to the lack of training on the topic (Fernandez-Solis et al., 2013).

The understanding and knowledge of IPD varies between organizations, projects, and potentially individual stakeholders. Some researchers firmly argue that IPD as an approach should be mandated by a contractual agreement (Cheng et al., 2016; Raisbeck et al., 2010; Korb et al., 2016; Miller et al., 2014; Daswani et al., 2015; El Asmar et al., 2013) with the expectation that contract clauses will change people and dictate how they will behave. However, culture and behavior cannot be legislated; therefore, contracts cannot change people’s behavior neither change the ingrained noncooperative environment that has been the status quo for years or traditional construction paradigms (Pishdad-Bozorgi and Beliveau, 2016b; Barker, 1993; Cheng et al., 2016; Ghassemi and Becerik-Gerber, 2011).
Others might highlight that integrated projects are those that rely on the use of technology such as BIM or other modeling technologies. However, as Ashcraft (2008) said, BIM will only help to solve superficial problems if used without collaboration. In other words, the use of technology in a project does not define the level of integration that exists. In this context filled with many different definitions, most researchers agree on defining IPD as a spectrum of integrated approaches (Pishdad-Bozorgi and Beliveau, 2016b).

While some Lean construction concepts are increasingly being adopted in Peru with support from Peru’s Lean Construction Institute, there is still a lack of knowledge in the market about IPD as a delivery method, its principles, and the tools to facilitate its implementation. Therefore, this study explores and analyzes construction practices in Peru and develops a conceptual framework that facilitates IPD implementation in three basic domains: i) the principles that shall govern an integrated project, ii) the tools that facilitate and sustain IPD in the project, and iii) the project governance structure that makes IPD more suitable for a given situation. The author also explores the maturity of the construction industry in Peru, with particular emphasis on infrastructure projects due their high levels of complexity, and later identifies potential improvements by analyzing the results of an extensive survey conducted by LCI Peru.

Infrastructure projects very often include the use of a completed facility (its operation and maintenance) as part of their scope; therefore, the entire life cycle of such infrastructure projects needs to be considered during project development and for the analysis of this study. This study aims to provide a conceptual framework for implementing IPD in construction projects throughout the different project phases, beginning from project definition all the way through to the use of a new facility. It also aims to address some of the main challenges that are presented in the current state of construction in Peru and add potential strategies that might assist in creating an integrated environment as part of the conceptual framework proposed for implementing IPD. These proposed steps include developing a sense of community and training participants in IPD related concepts, basic principles, means, and tools as well as incentivizing the participants’ willingness to change.
3.3 Research Statement and Objectives

3.3.1 Research Statement

Integrated Project Delivery (IPD) as a collaborative delivery method has brought many improvements to the construction industry in terms of project performance, sustainability, work environment and the overall delivery of value to clients. The thesis of this research is that successful implementation of IPD will enhance the delivery of infrastructure projects in Peru in terms of metrics such customer relations, safety, schedule, cost, quality, financial metrics, communication, and collaboration due to IPD’s potential for dealing with highly complex projects. Various psychological factors foster the successful implementation of IPD. Also, its implementation includes various principles, tools, and a governance structure that are described in this chapter.

3.3.2 Objectives

Chapter 3 aims to provide readers an overview of the implementation of IPD around the world. The main objective of this chapter facilitates users with a guide for systemic implementation of IPD. Other objectives are:

- Understand what motivates the overall industry moving towards collaborative delivery systems such IPD in construction.
- Get to know how the desired behaviors are being fostered for sustaining collaborative projects.
- Analyze what factors enable trust and make IPD sustainable over time by establishing long-term relations.

3.4 Methodology

The author used a systematic literature review (SLR) of the existing body of knowledge to understand the landscape of IPD application in the world. A systematic analysis of the literature addresses clear questions that had been previously formulated by the researcher and it uses systematic methods for identifying resources and analyzing the content of the body of knowledge to report valid and reliable results (O'Brien and Mc Guckin, 2016). Okoli and Schabram (2010) define SLR as “a systematic, explicit, and reproducible method
for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners. In the first phase of the study, the author performed a tertiary analysis to review secondary sources on IPD (Kitchenham and Charters, 2007; Nurdiani et al., 2016; Arasteh et al., 2017; Opdyke et al., 2017) since: i) the topic of IPD has been researched extensively over the past decade, but ii) the existing studies of IPD remain fragmented and cover a wide range of practices and issues under the label of integration. Therefore, a systematic review of past literature illuminates the landscape of research on integration in the project management field. The analysis further aimed to outline the extent and context of current principles that are being applied when working with an IPD approach to classify and categorize existing practices and explore patterns across prior studies. The author created a database of journal papers, conference papers and articles were found through the internet and added other sources from practitioners and experts that were solicited and got them by email. Only documents written in English were considered in the analysis.

The search primarily started with “integrated project delivery” as the keyword in the Scopus database. This search resulted in 282 manuscripts, which were then complemented with the results found from searching the same term in five additional journals including the International Journal of Project Management, Journal of Management in Engineering, Project Management Journal, Journal of Construction Engineering and Management, and Construction Management and Economics. This search increased the number of manuscripts to 430. In addition, 28 articles were added at the suggestion of Lean practitioners and industry experts who sent the papers by email at request of the author. The titles and abstracts of the 458 gathered manuscripts were then reviewed to remove any irrelevant or duplicated works. The criteria for the vetting process involved keeping papers that used integration for any formal or informal interactions between entities and thus took into account ideas such as collaboration, co-creation, and contractual involvement. The author examined each publication to decide whether it answered any of the study’s specific research questions. The majority of the 328 manuscripts removed were pulled due to lack of topic relevance; 103 works focused mainly on virtual reality or BIM coordination for interferences and prefabrication, 54 focused only on contractual agreements, 39 focused on educational purposes such as adding IPD as a subject to a school curriculum, 33 focused
on sustainability and green building, and 30 focused on alliancing or partnering only. Moreover, 25 manuscripts were removed due to duplication, and 44 papers were pulled because they themselves were reviews or addressed other irrelevant topics. These latter topics included considerations of adding Lean and IPD courses to university curricula, supply chain optimization, and BIM as a modeling technique.

The resulting 130 manuscripts (Table 3.1) were imported to NVivo 12, which is a qualitative data analysis software for further coding and analysis (QSR International, 2018). A quality check was not performed at this stage because of the abundance of practitioner-based papers on the topic. The author used a combination of inductive and deductive coding strategies; inductive strategies include a detailed analysis of resources through close reading the materials while deductive coding start with specific words of themes and then explore them in the sources (Opdyke et al. 2017) to answer the four initial research inquiries: i) What is the extent of the use of the term “integration”? That is, what do the researchers mean when they use the term (inductive) (e.g., collaboration, alignment, etc.) ii) What are the common patterns in current practice that support IPD as a project delivery method? (deductive); iii) What has been explored in regard to shared governance (understanding a project governance structure, collaborative decision-making, and sharing risk and rewards) when working in an integrated team? (inductive); and iv) What research has been done on attitudes, beliefs, expectations, and potential barriers concerning the application of an integrated approach (i.e., IPD)? (inductive). Inquiries one, three, and four used an inductive coding strategy while inquiry two used a deductive strategy. Nodes were created in NVivo based on these four research inquiries. Figure 3.1 shows the process followed to perform the systematic literature review of the existing body of knowledge. In developing the coding process, parent and child nodes were created based on the author’s reasoning and in logical flow to answer the research questions. Content analysis was then performed at the elimination stage where the little and abstract of each paper was reviewed to exclude unrelated papers. A synthesis of the findings is presented in the next section.
A total of 130 out of 458 papers were considered, representing 29% of the total number of documents gathered as a part of the study.
### Table 3.1 Details of Integrated Project Delivery Articles Identified in the Research Study

<table>
<thead>
<tr>
<th>Source</th>
<th>Initial sample</th>
<th>Articles removed</th>
<th>Final sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus</td>
<td>282</td>
<td>196</td>
<td>86</td>
</tr>
<tr>
<td><em>Construction Management and Economics</em></td>
<td>30</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td><em>Journal of Construction Engineering and Management</em></td>
<td>70</td>
<td>66</td>
<td>4</td>
</tr>
<tr>
<td><em>International Journal of Project Management</em></td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td><em>Project Management Journal</em></td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>Journal of Management in Engineering</em></td>
<td>34</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Other Sources</td>
<td>28</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>458</strong></td>
<td><strong>328</strong></td>
<td><strong>130</strong></td>
</tr>
</tbody>
</table>

During the coding process, the author created parent and child nodes (Fig. 3.2) to answer the research questions, categorized the information according to the appropriate code, and interpreted outcomes to summarize current practices and develop a conceptual framework for implementing an integrated approach.
As part of the SLR process, NVivo 12 software also helps running queries for word frequency that analyzed the content of all the files uploaded and creating word clouds (see Fig. 3.3) that allowed the author to analyze the focus and intent of the researchers on the topic.
Chang (2014) points out that to address problems more systematically, setting out a framework is useful; therefore, the final outcome of this chapter as a result of the systematic literature review developed is a conceptual framework that facilitate IPD implementation. The conceptual framework also describes the attitudes that will enable IPD implementation and a potential organizational structure for integrated projects. The conceptual model can serve as a guide or framing mechanism for practitioners to explore the applications of IPD principles and tools and consider the expected behaviors that will facilitate IPD implementation by aligning stakeholders’ goals and expectations.

3.5 Psychological Factors as Catalysts for Implementing IPD

The psychological implications of integration of the research included a focus on the enablers of IPD. The author aimed to assess the main drivers for implementing an integrated approach, and therefore analyzed three different parts: i) What enable or motivate individuals, teams, and organizations to migrate to IPD, ii) What would enable...
the behaviors expected in an IPD environment, and iii) What would enable trust throughout the stakeholders to make IPD sustainable. Olander (2007) explained how different stakeholders expectations can greatly affect project outcomes, consequently the researcher started the analysis understanding why people would move and put effort on working differently.

There is an expectation that projects using a collaborative project delivery method are more cost beneficial than noncollaborative projects (Kulkarni et. al 2012). According to McGraw Hill Construction (2013), Lean practitioners initiated Lean practices with a high expectation of achieving greater productivity, as a potential in a highly competitive industry such as construction. In this industry, productivity and efficiency determines the presence of companies in the market. There is a need for transforming current practices to a more transparent and integrated approach and therefore achieve collaboration and break the silos in construction (Forero et al., 2015) and this goal of collaboration cannot be achieved without considering the nuances in attitudes and beliefs from stakeholders. Construction industry in Latin American countries is still developing and people tend to practice very traditional methods. However, a report from McGraw Hill Construction (2013) showed that around 70% of people in construction industry in USA consider IPD implementation appropriate for dealing with current problems in construction and this fact might motivate people to change. The application of IPD in Colombia, a country with a relatively similar construction culture to Peru, was studied by Forero et al. (2015) and study suggested that i) a great majority of stakeholders is aware of problems of the industry and agreed in the need of mechanism that can guarantee more effective results, ii) several groups are interested in the transparency and equality between teams, iii) the fear of change is still a barrier to implement changes and some groups oppose the open and transparent methodologies, considering it as unnecessary or dangerous.

3.5.1 Expectations that Enable Migrating to IPD

The overall construction industry is changing and IPD seems to be the natural answer or solution for addressing most of the current construction issues existing nowadays. In order to understand what motivates such migration to IPD, the researcher listed the main causes that individuals applying IPD expect from the process as follow:
• There is substantial room for improvement in the AEC industry where IPD promises better outcomes in terms of productivity, quality, safety and work environment (Changali et al., 2015; Smith and Rybkowski, 2012) but also help the clients define what exactly they want and what can the team deliver within clients’ constraints such as budget and time (Sarkar and Mangrola, 2016; AIA, 2007; Ballard, 2008; Tillmann et al., 2012).

• Many authors pointed out the need for improving team integration and create a team-oriented culture to deal with the high level of complexity that projects demand (Mollaoglu et al., 2015; Cheng et al., 2012; Cheng et al., 2016) and improve project outcomes by investing in the people responsible for delivering value (AIA, 2007) in an environment where each participant is committed to the success of the others (Ballard et al., 2015).

• When owners have a clear understanding of what IPD is and how they would benefit from it, they will become a catalyst for migrating to that time of delivery method (Sarkar and Mangrola, 2016).

• Even with traditional contracts, the team can opt for adding certain addendums spelling out mechanisms for alignment, and specific tools and principles to apply (Cohen, 2010) or get a high level of alignment by making sure all team members understand project objectives and the importance to the client (Ballard et al., 2012).

• For IPD to succeed, team members from all parties need to take on new roles and embrace the new way of working where knowledge is exchanged all around (AIA, 2007; Sparkling et al., 2016), commit to project goals and build a leadership culture which will embrace cultural change that is a requirement to make IPD sustainable (Ballard et al., 2007; Ballard, 2000a; Zimina et al., 2012; Sutte, 2013; Chesworth et al., 2010).

• Even though change and uncertainty are always present, complex to managed, and difficult to deal with, it is possible (Ballard et al., 2007).

• Culture is seen as the main driver for project success (Cheng et al., 2016)

• Having a champion with expertise in IPD and Lean is key for a successful implementation (Cheng et al., 2016).
• Infrastructure projects involve multiple organizations working together and it requires deep levels of trust among partners (Liu et al., 2016).

• Yu et al. (2006) highlighted that success is the ultimate purpose of each project and it heavily relies on understanding the needs and expectations of the parties involved (Atkin and Skitmore, 2008; Yang, 2010).

• Reducing the cost in IPD projects is not the focus, but the increase in value (Hanna, 2016), user satisfaction, and occupant wellbeing (Mollaoglu-Korkmaz, 2013; Howell, 2010).

• Parties bring gains and long-term benefits to the project by keeping a convergent vision (Zhang and He, 2015; Aapaoja et al., 2013; Suttie, 2013) when a sense of belonging invades participants and collaboration occurs (Pishdad-Bozorgi and Beliveau, 2016b).

• IPD requires that all parties take ownership (AIA, 2007), such ownership is created by defining roles, responsibilities, competencies, and involving project parties and suppliers into the decision-making and problem-solving process properly (Kent and Becerik-Gerber 2010; Hughes et al., 2012; Ballard, 2006).

• Projects aim to eliminate contingency (Cohen, 2010), remove hidden schedule and cost buffers (Thomsen et al., 2010).

• Commitment of the top management (Salem et al., 2005) and reliable promising of team members (Lichtig, 2006).

• Selecting parties in IPD implementation is key (Zhang et al., 2015; Ghassemi and Becerik-Gerber, 2011) as well as the attitude and personalities of the team members (Fakhimi et al., 2016; Korb et al., 2016).

• Participants with expertise in IPD said that public projects would benefit from IPD (Collins and Parrish, 2014), in addition Alp and Franz-Joseph vonWerssowetz (2013) also supported the idea that government agencies would gain from being part of the IPD process, and Kulkarni et al. (2012) stated that collaborative models produce more reliable outcomes for public projects. Due to the capacity of government agencies and their compromise to serve the entire population, they have the power to motivate and lead change including legislation or specific policies (Bonham, 2013).
3.5.2 Enabling Behaviors that Facilitate IPD

Authors suggested different factor that enable behaviors that facilitate IPD implementation:

- Business case or market advantage since more owners are looking for trusted and capable organizations (Do et al., 2015; Cheng et al., 2011; Bryson, 2010; Kenig et al., 2010; Pishdad-Bozorgi, 2017; Aapaoja et al., 2013) that can deliver projects in an integrated manner (Levitt, 2007) and more organizations are willing to adopt IPD (Forero et al., 2015) to better deliver value and served clients (Mossman et al., 2010; Ballard et al., 2012; Zhang et al., 2015; Forero et al., 2015; Aapaoja et al., 2013).

- Sense of urgency for changing (Ballard et al., 2007; Nawi et al., 2014b; CURT, 2004) and dissatisfaction with status quo and recognition that the current construction industry being delivered with traditional methods is no longer sustainable due escalation of costs, projects delayed and with cost overrun, quality being compromised, frequent claims (Kenig et al., 2010; Do et al., 2015).

- More organizations placing emphasis on IPD principles and tools, motivating, aligning, and mentoring team members and building high-performing teams (Cheng et al., 2016).

- During selection of participants, considering partners that can work collaboratively and buy-in the process of IPD and build team chemistry (Pishdad-Bozorgi and Beliveau, 2016b; Dossick et al., 2013).

- Understand the benefits and the potential of IPD to lead to cultural change and train participants to overcome resistance (Cheng et al., 2016; Kim et al., 2016; Suttie, 2013) by sharing previous case studies. For example, Fernandez-Solis et al. (2013) conducted a study in which more than 50% of participants in the AEC industry are willing to change and migrate to new delivery systems, Forero et al. (2015) developed another study in which 70% of participants show willingness to work under IPD system, and Kent and Becerik-Gerber (2010) reported that almost 60% of experienced participants on IPD said that it would work well with all type of projects, while other previous case studies (Kenig et al., 2010; Cheng et al., 2016) showed participants found value on IPD and said that the silo mentality disappeared from top down in their projects.
• Incentives to join the parties early and find out potential issues before they occur (Korb et al., 2016).

• Repeated or pre-existing relations (Mollaoglu-Korkmaz, 2013; Pishdad-Bozorgi, 2017) that create a level of relationship that allows for working out problems easily and faster since there is a preexisting relationship and the flow of knowledge is increased (Thomsen et al., 2010; Korb et al., 2016). Also, the process itself provides participants the opportunity to keep involved in learning routines to enable continuous learning, communication, and mutual understanding through mentorship (Cheng et al., 2012; Chan et al., 2010; Eriksson, 2010).

• Participants’ willingness to devote time, resources, and energy to the process (Klein and Sorra, 1996).

• Having parties involved in discussions give them a sense of ownership (Hellmund et al., 2008).

• Believe that success if the sum of many things and it is supported and created by leadership that foster communication capabilities, cultural alignment, influential, and ownership (Ballard et al., 2007; Walker and Lloyd-Walker 2011; Kenig et al., 2010; Zimina et al., 2012).

• The need for being sensitive to each other’s concerns, needs and understand their perspectives (Mollaoglu et al., 2015; Zhang and He, 2015; Goleman, 2000; Walker and Lloyd-Walker, 2015), treat each other with respect and appreciation (Pishdad-Bozorgi and Beliveau, 2016b; Che Ibrahim et al., 2013) and improve team collaboration through supporting each other’s back (Kenig et al., 2010) and paying more attention and building partnering relationships believing on people’s competency (Zhang and He, 2015).

• Recognition that “no one is a helpless victim of fate” and everyone can pursue the changes they want and have the power to change things (Ballard et al., 2007).

• The establishment of a sharing risk and reward mechanism or the inclusion of the company into the incentive pool encourage and motivate parties to shift from individual thinking to team thinking where everybody is in the same boat and contribute their resources with the aim of improving the project as a whole while continuously improve participants’ skills (Cheng et al., 2016; Zhang and He, 2015;
Kahvandi et al., 2017; Gallstedt, 2003; Alp and Franz-Joseph vonWerssowetz, 2013; Hoezen, 2012; Darrington, 2011). Levitt (1995) and Ashcraft (2011b) highlighted that economics is a key root incentive to foster aggressive collaboration, and therefore, when teams share risks and rewards, they are somehow pushing stakeholders to work as a team in the best interest of the project (Moynihan and Harsh, 2015) and deal with the natural resistance to change (OECD, 2009).

- Designing a space in which collaboration can be fostered through visual aids, and add collaboration practice in place that make the team more united (Kokkonen and Vaagaasar, 2017; Pishdad-Bozorgi, 2017). Weekly work plan meetings are perceived as one space that foster collaboration within teams (Fernandez-Solis et al., 2013) and an opportunity to get timely and consistent feedback and share knowledge within and among trades (Changali et al., 2015; Tatum, 2012).

- Face-to-face work that facilitate social interaction and build proximity (Zhang and He, 2015) with highly committed participants who are actively involved and engaged in processes such goal setting, performance evaluation, and overtime will increase clarity, trust, collaboration, respect, accountability, shared learning, make communication flow (Thomsen et al., 2010; Paik et al., 2017; Cheng et al., 2016).

- Encouragement for project managers and executives to migrate to collaborative practices because group leadership is key in IPD (Suprapto et al., 2015; Nishizaki and Seed, 2015; Sun et al., 2015; Seed, 2014) where “leadership has a different flavor” (Knapp et al., 2014) that makes people feel an environment of “psychological safety and mutual trust” (Yukl, 2012) which is supported by participants’ willingness to work with integrity, enthusiasm, and positive attitude (Sparkling et al., 2016) and make decision on a “best-for-project” basis (Manley and Chen, 2017; Alp and Franz-Joseph vonWerssowetz, 2013) guided by good leadership and supported by a team (Manley and Chen, 2017; El Asmar and Hanna, 2012) since individuals’ success is tied and dependent on overall project success (Mossman et al., 2011).

- Young professional with new skills and tools (Kenig et al., 2010) who understand the benefits of working collaboratively (Zhang and He, 2015) and feel the need for
balancing powers (Walker et al., 2016), empowerment and equality for team members (Kenig et al., 2010).

- Listen to people will give them the sense to feel more powerful, influential and competent (Lichtig 2007).
- Training is critical to overcome resistance and enhance team members capabilities, improve their understanding and perception of IPD (Ballard et al., 2007; Kim et al., 2016; Ghassemi and Becerik-Gerber, 2011) and create shared processes and understanding of how each trade can impact the project (Thomsen et al., 2010; Suttie, 2013).
- Social activities create a dialogue space and are also considered important for making people get along and foster innovation because people feel more freely to speak up (Cheng et al., 2016).

3.5.3 Factor Enabling Trust to Sustain IPD

Trust is in the core of IPD and it is built on various elements (Hsu et al., 2007). Some authors (Clark & Payne, 1997; Thomsen et al., 2010; Kumar, 1996) said that trust is a requisite for IPD collaboration while others said that IPD process actually builds trust over time and trust becomes an output rather than an input because IPD offers rapport in projects which foster respect and trust (Pishdad-Bozorgi and Beliveau, 2016a; Cheng et al., 2016; Smith and Rybkowski, 2012), but there is definitely a symbiotic relationship with a strong correlation between both (Pishdad-Bozorgi and Beliveau, 2016a; Zhang and Peng, 2015; Jacobsson and Roth, 2014).

- “Trust is a dynamic attribute, which either grows or diminishes through time” (Pishdad-Bozorgi and Beliveau, 2016b). As collaborative practices are implemented, trust within the team grows and unfavorable prior experiences of opportunism will vanish (Walker, 2008; Drexler and Larson, 2000; Zollo and Winter, 1999).
- Collaboration in early stages of the project (Ghassemi and Becerik-Gerber, 2011), meaning that downstream players get involved in upstream activities for the betterment of the project.
The recognition that trust is fundamental to empower the team members to take responsibility and generate accountability, increase commitment, and foster constructive discussions (Walker et al., 2002). As people start working as partners committed to achieving what is best for the project (alignment), a community is being built and trust emerges in such environment.

Previous experiences and long term relations (Zhang and Peng, 2015; Pishdad-Bozorgi, 2017; Fish, 2011; Ghassemi and Becerik-Gerber, 2011), information flow and information sharing (Zhang and He, 2015; Pishdad-Bozorgi and Beliveau, 2016a; Pishdad-Bozorgi and Beliveau, 2016b; Pishdad-Bozorgi, 2017; Aapaoja et al., 2013), sharing risk and reward through equitable mechanisms (Cheng et al., 2012; Pishdad-Bozorgi and Beliveau, 2016b; Pishdad-Bozorgi, 2017; Kadefors, 2004), organizational, communicational, and contractual strategies (Pishdad-Bozorgi and Beliveau, 2016a; Aapaoja et al., 2013; Ghassemi and Becerik-Gerber, 2011), integrity and reputation (Pishdad-Bozorgi, 2017; Pishdad-Bozorgi and Beliveau, 2016a; Cleves and Gallo, 2012), commitment to continuous improvement (Ghassemi and Becerik-Gerber, 2011; Lahdenperä, 2012), empowering team members (Pishdad-Bozorgi and Beliveau, 2016b), as well choosing accountable parties in a fairly way (Kenig et al., 2010) build trust.

IPD also requires respect and it in terms builds better relations and trust (Ashcraft, 2011a).

Trust relies on reliable promises and making and keeping commitments (Mossman et al., 2010; Mossman et al., 2011; Ballard and Tommelein, 2011; Thomsen et al., 2010; Liu and Bates, 2013; Ghassemi and Becerik-Gerber, 2011).

Experimentation and failures are seen as opportunities for improvement and it helps people feel confidence (Ballard et al., 2007; Aapaoja et al., 2012) while providing them a sense of belonging (Pishdad-Bozorgi, 2017) and engaging them on open discussions and the definition of processes and standards (Ballard et al., 2007; Ballard et al., 2012).

As teams share everyday activities such having lunch, talking about things in common, they become acquaintance and later friends (Thomsen et al., 2010).
• Openbook and other transparency mechanisms on project performance that allow an open dialogue also to break down barriers and build trust because it creates reciprocity within members (Seed, 2014; Cheng et al., 2016; Pishdad-Bozorgi and Beliveau, 2016b; Pishdad-Bozorgi, 2017; Ghassemi and Becerik-Gerber, 2011; Jacobsson and Roth, 2014).

• Training (Ghassemi and Becerik-Gerber, 2011) such team building exercises (Pishdad-Bozorgi, 2017), multitrade planning sessions (Howell, 2010), and more time devoted towards educating participants on IPD (Nanda et al., 2016) is important.

• In places where owners lack of knowledge in regards of IPD, general contractors can start and lead them throughout the process, then if the contractor work in an IPD model and build trust, there is a chance that the clients would return the same behavior over time (Wong et al., 2005).

3.6 Integrated Project Delivery in Practice

There is an increasing trend in the engineering and construction industry toward adopting collaborative principles for project delivery that can be used either when pursuing IPD as a delivery method or IPD as a contractual agreement (Rahim et al., 2016; Ke et al., 2015; Kenig et al., 2010). As with other implementations, IPD implementation involves the application of certain methods and tools (Ballard et al., 2007). The present study’s findings yield a broad overview of the most common IPD practices and strategies, which will become a part of the framework. This study summarizes the results of different case studies and public reports on projects that used IPD, so the author has built the argument for IPD based on the common patterns that were detected.

3.6.1 Shared Governance

Projects are built by people and traditional construction is characterized by complex and adversarial relationships among project stakeholders (Palacios et al., 2011), in such context, a key strategy to deal with such relations is team integration (Cowan et al., 2001; Che Ibrahim et al., 2013; Latham, 1994). The lack of shared governance during the construction period of traditional delivery methods concealed productivity problems faced by some
contractors and hindered the constant analysis of changes in expected costs through time (Ballard et al. 2015). Having identified the psychological factors influencing integration in section 3.2, the next step is to analyze the shared governance structure governing IPD with certain degree of flexibility which is important in promoting a team environment since there is a need to convey all stakeholders into a single organization that support the project as a unit no matter who pays for their salary (Mossman et al., 2010; Do et al., 2015). To do so, the author divided the section of shared governance in three categories which include project governance, collaborative decision-making and sharing risks and rewards. First, defining a governance structure for integrated teams is important for aligning the participants, managing the whole project team jointly, and setting and steering to targets in construction because governance directly influences project performance with a single focus on delivering greater value (Manley and Chen, 2017; Lenferink et al., 2012; Mossman et al., 2011; Do et al., 2015; Zhang et al., 2013; Tillmann et al., 2012; Love and Gunasekaran, 1998; Fleming and Koppelman, 1996; Moore and Dainty, 1999; Baiden et al., 2003; Baiden et al., 2006). Second, as Walker et al. (2016) described in its logic of collaboration, the shared understanding of a project facilitates decision making. Third, sharing risk and reward to overall project outcomes help aligning interests, and a collaborative decision-making process help getting the most from team expertise and creates confidence and accountability (O’Connor 2009). Moreover, the call for shared governance might be challenging for some professionals, despite the existing need in the industry for a transformational change (Ballard et al. 2015).

The integrated governance model aims to ensure that the responsibility of work is distributed across the team members and aims that maintain relationships in difficult times by the use of relational agreements. For example, the cluster leaders are responsible for the onboarding process. This governance structure avoids bottlenecks in the decision-making process and gives more control to the people doing the work at the cluster level. Shared governance looks for parties committed to a common culture (Pishdad-Bozorgi and Beliveau, 2016b; Franz et al., 2017; Mollaoglu-Korkmaz et al., 2013) where the goal is to improve the collective understanding of the project, increase team commitment, and align the interest of different parties by avoiding the potential for adversaries in the relationships.
Authors (Chen and Manley, 2014; Lahdenperä, 2010; Love et al., 2011; Rahman and Kumaraswamy, 2012) highlighted formal and informal governance mechanisms which include a variety of contractual incentives for sharing risk and reward and noncontractual incentives for improving team work, facilitate open communication and share knowledge, and enable cooperation and build mutual trust. In addition, Chen and Manley (2014) suggested that complex infrastructure projects require both a mix of formal and informal mechanisms to be managed effectively; however, they also pointed out that the implementation of informal mechanisms such the ones that aim to build different behaviors in project stakeholders towards teamwork give more accurate predictions of project performance, giving a highly importance to informal mechanisms.

Lank (2006) highlighted that private and public organizations take advantage of integrating teams where all together can deliver greater value than by their own and it is tuned into the needs of the client (Aapaoja et al., 2012).

### 3.6.1.1 Project Governance

The project governance structure aims to define the relationships between the project players within and from different organizations and ideally when having integrated teams, it should support an environment of openness, transparency, and commitment where everybody is interest in achieving a successful project (Walker et al., 2016). It is important to define how a team should operate in a collaborative environment. In fact, having the right people involved is key for success (Christiansen, 2009), and individuals who can operate in such collaborative environment should be sought. Xue et al. (2010) have identified that the organizational culture has a significant impact on fostering collaboration, and IPD projects in particular are governed by personal relationships (Pishdad-Bozorgi and Beliveau, 2016a). Baiden et al. (2006), Zhang and He (2015), and Ballard et al. (2012) suggest that an integrated team creates a culture of efficient and effective collaboration where participants are pursuing common goals and supporting value generation (Tillmann et al., 2012; Winch and Bonke, 2002; Aapaoja et al., 2013; Winch and Bonke, 2002; Austin et al., 2002; Jaafari and Manivong, 1999), which places special emphasis on the social long-term relations among teams (Henisz et al., 2012). Moreover, an integrated team also aims to offer equal opportunities to parties, thus creating reciprocity, a positive reputation,
and trust (Zhang and Peng, 2015; Pishdad-Bozorgi and Beliveau, 2016a; Pishdad-Bozorgi and Beliveau, 2016b; Love and Gunasekaran, 1998; Baiden et al., 2003). Kenig et al. (2010) have highlighted not using employee talent as one root cause of waste in construction. The Construction Users Roundtable (CURT) (2004) and Demirkesen and Ozorhon (2017) suggested the need for change in project teams and proposed an integrated project structure or the integration of staff for the different stages of a project life cycle, and Mitropoulos and Tatum (2000) have highlighted the importance of fostering individual and team skills at the project level. Chen and Manley (2014) have identified informal governance mechanisms that influence human capital and intellectual acumen (Naney et al., 2012; Williamson, 1979), such relationship management, leadership skills, team workshops (Tillmann et al., 2012), communication systems, and design integration. Integration can be defined as cross-functional system based on collective responsibility (Follet 1933). Sparkling et al. (2016) have suggested that some components for establishing an integrated organizational culture are aligning goals, getting team member commitment, and fostering innovative and alternative options for decision-making. Furthermore, Hickethier et al. (2013) argue that key mechanisms and roles in IPD projects include cross-functional clusters, chief engineer, core group among others. In well-structured teams, behaviors are predictable, and confidence grows because there is mutual understanding about the scope of the project at hand (Hsu et al., 2012).

Cheng et al. (2016) recommend that organizations maintain effective processes to identify new potential team members, select key partners, and build a team. Moreover, Matthews and Howell (2005) have pointed out that the best way of governance is through self-governance in which the goal is to constantly build people. Meanwhile, Seed (2014) suggests the use of dashboards to more easily share goals and status updates with the whole team.

Ballard et al. (2007) recommend that when companies want to adopt this different approach, they consider bringing an external consultant to provide guidance in setting up a strategy and a formal training process to helping them along their Lean journey. Some practices for integrating teams include holding workshops, benchmarking, conducting team-building sessions, and using an external facilitator with a final aim of developing mutual goals and objectives (Sparkling et al., 2016; Tillmann et al., 2012). A
key action for building a collaborative culture is to engage the different players in a project and take the time to understand their concerns (Kenig et al., 2010).

Liker (2004) wrote in *The Toyota Way* that organizations need to grow leaders who can deeply understand the company’s processes, own its culture, and share it with others while encouraging an environment of respect between partners and suppliers.

Defining a structure for project governance in IPD projects is important since the structure will define the relationships that exist between individuals on the team (Porpora, 2013).

The authority over project management, top management support for clients, team competency, and staff integration are some of the critical factors in a construction project’s success (Kog and Loh, 2012; Demirkesen and Ozorhon, 2017). Different contexts will influence team collaboration in different ways (Poirier et al., 2015). A project governance structure amenable for IPD shall be extended from covering individuals and teams to account for entire organizations and even further beyond the supply chain members. All members should work to move the project forward and build mutual understanding, respect, and a shared vision and culture.

According to Do et al. (2015), a project governance structure consists of a core group, a community of practice, cluster leaders, and cluster members. On the other hand, Hickethier et al. (2013) argues that an effective project will operate in cluster groups that are under the supervision of the core group and the chief engineer.

When fostering an integrated project governance structure, it should be noted that specific mechanisms can stimulate and enhance collaboration, mutual respect, interaction between players, and knowledge sharing (Love et al., 2010; Lahdenperä, 2012). Cheng et al. (2012), Mossman et al. (2010), Mann (2010) and Mossman et al. (2011) have identified the following as desired characteristics for team members operating within this new way of governance structure: innovative, entrepreneurial spirit, and leadership skills. Do et al. (2015) also assert than an organization should be structured to promote the flow of communication between the clusters groups and the core group.

Some researchers (Thomsen et al., 2010; Cheng et al., 2016; Singleton and Hamzeh, 2011; Christiansen, 2009; Matthews and Howell, 2005) believe that the best way to form a team is to have individuals participate in separate assessments and then choose team members based on the idea of designating the right person for the right function in order to form a
high-performing team. Morgan and Liker (2006) suggest that young engineers must get to know the processes in a given project and develop basic competencies in their efforts to fully integrate suppliers into the delivery of the project.

### 3.6.1.1 The IPD Leader

McKew (2009) and Fish (2011) introduced the role of the *IPD leader or facilitator* who embraces transformational leadership (Nishizaki and Seed, 2015) and is responsible for guiding the team through the IPD process. This individual should also be knowledgeable of IPD tools and principles; this trait is particularly necessary when teams lack previous experience with IPD or the level of trust within the team has not been developed as much as needed. Such the leader will ideally be equipped with the skills to understand how to make individuals work effectively in teams. Poirier et al. (2016) and Poirier et al. (2015) also argue that context is a very powerful factor that influences collaboration, and the facilitator is the person who must properly create the environment needed to encourage and foster such collaboration. Meanwhile, Jacobsson and Roth (2014) recommend that the facilitator focus on promoting dialogue and building loyalty. Seed (2004) has also highlighted the demand for a new kind of leader who is capable of managing the involvement of different parties early on in a project’s life cycle and possesses the skills of facilitation, organization, and team and change management; this leader is expected to deeply understand the relations, roles, and responsibilities of the different parties involved in the project delivery. Also, Kennedy (2003) suggests that a leader should have a participative role and seek to define the changes and challenges of a project to the team to get members involved in the definition and execution of such changes. Meanwhile, Sun et al. (2015) have noted the role of the team leader in making appropriate decisions through which benefits can be brought to the project as a whole. As Matthews and Howell (2005) have suggested, all team members should wear the same hard hats with a shared logo, and the leader plays a key role in making this vision a reality.

Do et al. (2015) suggest that organizations starting their Lean journey add an external consultant to guide the company in defining its integration strategy and creating a training plan. Moreover, Hill et al. (2007) have said that a facilitator’s main goal in meetings should be to guide the team to a resolution, an agreement, or a plan of action when problems arise.
Hill et al. (2007) argue that leaders should give reasons for taking action and set directions for changes to speed processes up and extend the impact of any changes made. Meanwhile, Cheng et al. (2016) analyzed case studies and identified some common processes such as identifying, selecting and awarding potential team members and later building a team and coaching its members throughout a project’s duration.

Leaders should focus on coaching their teams and developing experiential learning exercises when training. In such context, Ballard et al. (2007) suggest implementing tools that have been used successfully in case studies and field experiments documented by other researchers. Furthermore, they emphasize sharing and constantly reminding participants about project objectives and stakeholders values using visual reminders whenever possible to make sure that team members understand why and when a specific change is needed and the roles they play in the change’s successful implementation. All of these actions will help create a sense of belonging and ownership among team members. It is important to keep in mind that even the way a question is being asked matters. According to AIA (2007), Do et al. (2015), and Thomsen et al. (2009), the roles and responsibilities within a team should be clearly defined, and leadership should be taken by the most capable member to execute specific tasks based on project needs.

3.6.1.1.2 Cluster Teams

According to a number of researchers (Cheng et al., 2012; Do et al., 2015; De Melo et al., 2013; Nicolini et al., 2001; Seed, 2014; Hickethier et al., 2013; Tillmann et al., 2012; Singleton and Hamzeh, 2011; Christiansen, 2009), cluster groups are multidisciplinary groups that are often assigned to work in specific areas and are integrated by designers, engineers, contractors, trade partners and suppliers as needed. These cluster groups own the leadership for taking actions, which is critical to Lean initiative success (Ballard et al., 2007) for mini-projects (enclosure, interiors, etc.). Cluster leaders are the role model within their teams and shall use Lean construction to perform planning while ensuring team members commitment and fostering continuous learning (Do et al., 2015). It is important noting that such cluster leaders pull together planning sessions to organize clusters, ensure commitment, identify and remove constraints, represent the cluster in integrated meetings, and foster continuous learning and application of Lean tools and principles. As individuals
work in integrated teams, they become part of a pluralistic network of people with different backgrounds who are all interacting in a balanced environment (Tillmann et al., 2014), and as a consequence, they become more willing to receive feedback and coach others, thus bringing more thoughts to the table, which in turn leads to multiples perspectives and expectations influencing in a single project (Macomber and Howell, 2005; Hill et al., 2007). In IPD, clusters or cross-functional clusters (Do et al., 2015; Cohen, 2010) are problem-focused teams that are assembled as needed. Such cross-functional teams work together to achieve joint goals (Pinto et al., 1993).

Cluster groups account on people’s desire to do their best for the project; therefore, innovation meetings are held whenever is needed or schedule with certain frequency to improve the project. Nanda et al. (2016) argue that innovative teams are comprised of major trade partners and have strong support from the virtual modeling team. Cluster leaders are part of the integrated team of the project and often visualize more long-term plans (Do et al. 2015). Also, Do et al., (2015) have summarized the roles of cluster teams and the integrated team in Table 3.2.

Table 3.2 Role of Integrated Teams and Clusters (Do et al., 2015)

<table>
<thead>
<tr>
<th>Area</th>
<th>Integrated Team (Cluster leaders)</th>
<th>Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull plan level</td>
<td>Macro</td>
<td>Micro</td>
</tr>
<tr>
<td>Check-ins occur</td>
<td>2 times per week</td>
<td>Daily or as-needed</td>
</tr>
<tr>
<td>Milestones come from</td>
<td>Master schedule</td>
<td>Macro pull plan commitments</td>
</tr>
<tr>
<td>Hand-offs between</td>
<td>Cluster leaders</td>
<td>Cluster teams</td>
</tr>
<tr>
<td>Break down work</td>
<td>1 week max</td>
<td>2 day max</td>
</tr>
<tr>
<td>Reflections</td>
<td>Every 3 weeks</td>
<td>Every 3 weeks</td>
</tr>
</tbody>
</table>

3.6.1.1.3 Core Group

Many researchers (Cheng et al., 2012; Do et al., 2015; ConsensusDocs 300; Knapp et al., 2014; Hickethier et al., 2013; Lichtig, 2008; Tillmann et al., 2012; Fish, 2011; Ghassemi and Becerik-Gerber, 2011; Lichtig, 2006) have identified a core group as being essential
to IPD, and in most of the cases, they argue this group would be integrated by an owner representative, designer professional, and general contractor who are all also part of the project team. The core group also provides primary leadership and is responsible for the delivery of the project; its coordination, management, and administration; and the setting of project evaluation criteria (Lichtig, 2006). This group follows the principles of IPD and is responsible for getting consensus on final decisions. Other responsibilities that belong to the core group include coordination and overall day-to-day management and administration. For the core group is also often referred to as the Project Management Team (PMT), executive committee, management group or something similar (Thomsen et al., 2010; Hickethier et al., 2013; AIA C191, 2009). According to Cohen (2010), the project management team (PMT) should have representation from the owner, architect, and builder in order to manage projects and make decisions by consensus.

3.6.1.1.4 Senior Management Team

Cohen (2010) and Tillmann et al. (2012) identify another critical group as the senior management team (SMT) and others (Nanda et al., 2016; AIA, 2009; Singleton and Hamzeh, 2011; Matthews and Howell (2005) use names such as the senior executive team (SET) or project executive team (PET). This group consists of owner, architect, and general contractor representatives who solve issues that the PMT cannot. Also, it is important to note that senior leaders should be involved with setting project goals and fostering a learning environment focused on constant improvement (Lostuvali et al., 2014). AIA (2009) states that the target cost should be defined by the core group. Dossick et al. (2013) suggest that the management team must recognize any project needs and work to actively reinforce, build, and maintain an integrated team culture. Do et al. (2015) have highlighted how a project is managed by the people in the risk pool.

3.6.1.1.5 Communities of Practice

Do et al. (2015) describe a community of practice as a valuable way to advance a team’s application of Lean behaviors, skills, processes, and tools. They also said that community of practice very often creates the spaces where learning can be fostered since it offers a time reserve for learning that no most people take by themselves for own initiative.
Thomsen (2010, p.29) refers that a community of practice is “a group of people who share a concern, interest or a passion for something they do and then develop further proficiency as they practice and regularly interact.”

Seed (2014) states that once a team has been properly established, the resulting intellectual capital can be used throughout the community on problem solving, risk elimination, and the integration and enhancement of production, quality, and safety.

Team member satisfaction plays an important role in fostering team effectiveness (Sumner and Slattery, 2010); therefore, establishing and maintaining good relations between team members adds value to the project.

3.6.1.1.6 The Project Implementation Team

Cohen (2010) defines the project implementation team (PIT) as the one that handles day-to-day issues, this arrangement has also been recognized by other authors (Nanda et al., 2016) as the project leadership team (PLT) and comprises members from the major stakeholders.

Seed (2014) has suggested that the project manager or integrated project manager (IPM) should build trust and respect among team members in an ego-free environment, possess strong collaboration and facilitation skills, lead the team in reflections, schedule regular trainings, have a clear vision and understanding of the project and its value proposition, encourage input and feedback, take actions for improvement, reward people who speak up, mentor and coach team members including suppliers, and be knowledgeable in production techniques and Lean tools and principles. The IPM should coordinate target cost with the clusters while empowering them to make certain decisions. It is key to empower team members since IPD is very dynamic in nature and leadership is passed on from one person to another as needed (Winstanley, 2011). Morgan and Liker (2006) and Lostuvali et al. (2014) emphasize the importance of leadership and how those in power should fully support any changes inside out, thus leading team members by example. Moreover, Morgan and Liker (2006) and Lostuvali et al. (2012) use the term Chief Engineer for the person appointed to guide the team and coordinate with the cluster groups and define what is needed and by when.
3.6.1.2 Decision-Making Process

Collaborative project governance calls for developing joint decision making and demands effective knowledge sharing and organizational alignment (Chen and Manley, 2014; Hauck et al., 2004; Love et al., 2015; Hall, 2017). Integrated project team members can think, coordinate, work, and decide effectively on a decision-making process that help handling projects complexity as a unit because it benefits from a common ownership of decisions (Fischer et al., 2014; Bakht and El-Diraby, 2015; Kenig et al., 2010; Cheng et al., 2012; AIA, 2007; Pisched-Bozorgi and Beliveau, 2016b; Lichtig, 2006). Decision-making process is truly collaborative in integrated projects (Kenig et al., 2010). In IPD, empowering enables individuals to be deeply involved in team discussions and in the decision-making process (Yukl, 2012; Sun et al., 2015), but at the same time create a network of decision makers who consider the lifecycle of the facility as a whole (Bakht and El-Diraby, 2015). Druskat and Wheeler (2003) said that collaboration and project performance is enhanced by empowering the project team members and a number of authors (Heravi et al., 2015; Mollaoglu et al., 2015) suggested project leaders and owners to define and continuously enhance the decision-making process they implement and develop an assertive structure for dealing with unanticipated problems. In integrated projects, teams work together on modeling problems and developing decision tools that consider facts, data, experience, faith, intuition and all the available information and also aims to get consensus on the solution which is focused on what the best for the project is (Bakht and El-Diraby, 2015; Abdun-Nur, 1970; Sarkar and Mangrola, 2016; Kenig et al., 2010; AIA, 2007; Chong et al., 2010; Gupta et al., 2009). AIA, (2007) said that collaborative teams implicitly consider certain level of equality within team members while ensuring that the value is being delivered (Do et al., 2015) as expected. It is key for a successful development of decision-making in projects to involve the right people at the right time to make reliable decision (Cheng et al., 2016). Collaborative environments allow the stakeholders to make decisions in an inclusive manner with open communication and other characteristics of integrated projects (Tillmann et al., 2014) and it includes the involvement of as many parties as needed because all parties are an integral part of the process (Christiansen, 2009) including sometimes many of the users’ participants (Tillmann et al., 2012) allowing for a more effective and informed decisions for the project.
3.6.1.3 Sharing Risk and Reward

Chen and Manley (2014), Walker et al. (2016), and Matthews and Howell (2005) identified risk and reward sharing as a formal governance mechanism that reward and encourage effective management aligned to the best interest of the project, other authors (Chan et al., 2010; Lahdenperä, 2012; Lenferink et al., 2012) support sharing risk and reward as the foundation of collaborative procurement models, while others (Teng et al., 2017; Pishdad-Bozorgi et al., 2016; Schroeder, 2014; Zhang and Li, 2014) saw sharing risk and reward as one of the most important characteristics of IPD since it directly collaborate in building, developing, and maintaining the business relationship between parties. In all cases, embracing risk and reward give a level of confidence to all parties and push them to work together because “if one wins, all win, and if one fails, all fail” (Pishdad-Bozorgi, 2017 pg. 14) and adversarial relationships are eliminated by a committed team in an environment where all pains and gains are shared properly (Rached et al., 2014; Lostuvali et al., 2014; Matthews and Howell, 2005; Alp and Franz-Joseph vonWerssowetz, 2013; Alarcon et al., 2013; Lostuvali et al., 2012; Aapaoja et al., 2012).

By collectively sharing risks and cost savings within members of a risk/reward pool (Ross, 2003; Cheng et al., 2016; Hall, 2017; Liu and Bates, 2013; Singleton and Hamzeh, 2011), the practitioners will start thinking on optimizing the project as a whole. Ballard et al. (2015) reinforced the idea that sharing risk and reward calls for shared governance; in addition, in order to work well, the team must create a sustainable mechanism that should also be maintained throughout the project execution. Shared risk and reward can be sustainable applied if principles of IPD and Target Value Design (TVD) are fully understood and applied. Some authors (Alarcon et al., 2013; Zhang and He, 2015; Changali et al., 2015; Pishdad-Bozorgi and Beliveau, 2016a; Ke et al., 2015; Pishdad-Bozorgi and Beliveau, 2016a; Pishdad-Bozorgi and Beliveau, 2016b; Teng et al., 2017; Yeung et al., 2012; Moynihan and Harsh, 2015; Koskela et al., 2006; Lostuvali et al., 2014; Lichtig, 2006) said that most risk and reward mechanisms are embedded in IPD contracts where the individual’s success is tied to the overall project’s success, and other authors (Thomsen et al., 2010; Kim et al., 2016; Collins and Parrish, 2014; Thomsen et al., 2009; Ma et al., 2017) suggested that teams can choose between various ways to share and fairly distribute risk and reward. Shared governance build also a win-win scenario through the alignment of
sharing risk and reward encourage and incentivize participants that support the achievement of project goals and the improvement of project performance while positively fostering collaboration and trust in a fair and equitable environment (Kenig et al., 2010; Cheng et al., 2012; Pishdad-Bozorgi and Beliveau, 2016a; Hall, 2017; Pishdad-Bozorgi and Beliveau, 2016b; Rahman and Kumaraswamy 2008; Moynihan and Harsh, 2015; Zhang and Li, 2014; Pishdad-Bozorgi, 2017; Alp and Franz-Joseph vonWerssowetz, 2013; Lostuvali et al., 2012; AIA, 2007). For making shared risk and reward sustainable, the team need to develop a fair compensation structure or compensation program which encourage, motivate, and inspire team members to give the most for achieving project objectives since they all depend on each other capabilities and foster knowledge sharing (Liu and Bates, 2013; Laan et al., 2011; Franz and Leicht, 2012).

### 3.6.2 IPD Principles

According to the *Cambridge Dictionary* (2018), a principle is “a basic idea or rule that explains or controls how something happens or works,” and *Merriam Webster’s Dictionary* (2018) defines a principle as “a comprehensive and fundamental law, doctrine, or assumption - a rule or code of conduct.” IPD principles have been since the concept of a master builder has existed and these principles have continued to change over time. The principles presented in this study are not defined in isolation; instead, they have been drawn from underlying principles of Lean in manufacturing, collaborative work, and Lean construction. There might be some overlap between independent definitions, but taken together, they cover how to best integrate all project stakeholders.

IPD aims to ensure the achievement of desired project outcomes through a collaborative structure. In 2016, Dodge Data & Analytics presented a study that shows a statistically significant correlation between use of Lean methods and better project outcomes, suggesting that projects that apply Lean are three times more likely to complete ahead of schedule and two times more likely to complete under budget. Critics consider IPD principles too complicated and Lean tools too rigid; however, there is an argument to be made that IPD principles and tools aim to be flexible and can be tailored to suit a wide range of projects.
Flores (1982) said that “a project is a network of commitments”. Commitments do not necessarily require contract forms, but the IPD principles that have been implemented do play an important role (O’Connor, 2009) because they serve as informal codes of behavior. Moreover, given that the behaviors created by using IPD principles or strategies tend to be stifled by commercial terms that discourage collaboration, the author did not emphasize analyzing the use of contractual agreements. The literature review provides a systematic survey of existing material such as the principles currently being used and their effects (Fink 2013). A summary of the IPD principles is provided in the subsection below based on the findings of many authors such Mossman et al. (2010), Kenig et al. (2010), and Ballard et al. (2015). The principles include the early involvement of all key participants, which means bringing the right people together at the right moment to deliver greater value; shared governance which involves risk and reward sharing; and a collaborative decision-making process. The application of these principles could potentially reduce the risk of project failure and deliver what the owner really needs. To achieve this, customers and suppliers should work together, and designers and contractors should define the scope of work and at some specific point engage the workers who will build the project (Ballard et al. 2015).

Ballard (2008) summarizes the big idea for true integration well suggesting that every member of the team shall share completely the responsibility for the entire project and set about correcting deficiencies or problems wherever they popped up without regard to who caused the problem or who is going to pay for it. IPD principles, methods, and tools will increase the connections between team members and encourage collaboration throughout the different phases of the project, optimizing a project as a whole, rather than any particular piece (Tillmann et al. 2012).

3.6.2.1 Create a Culture of Mutual Respect and Trust

Trust is critical to the success or failure of construction projects (Egan, 1998; and Swan, 2002) and even more, it is a cornerstone for collaborative delivery methods such partnering (Spekman, 1988). Mutual respect is an intrinsic principle in IPD teams where all players are committed to working in the best interest of the project (Alp and Franz-Joseph vonWerssowetz, 2013; Hanna, 2016; AIA, 2007; Kenig et al., 2010; Cohen, 2010; Cheng
et al., 2012; Kim et al., 2016; Kent and Becerik-Gerber 2010; Walker et al., 2002; Fish, 2011; Liu and Bates, 2013; Che Ibrahim et al., 2013). Commonly, people are averse to being betrayed (Bohnet et al., 2008; Bohnet and Richard, 2004), and in such context, respect by others helps building relationships and trust (Ashcraft, 2011a). Additionally, Ghassemi and Becerik-Gerber, (2011) and Lahdenperä, (2012) suggest that mutual respect and trust is fostered by collaboration and commitment to continuous improvement. Pishdad-Bozorgi and Beliveau, 2016b; Pishdad-Bozorgi et al., 2016; Franz and Leicht, 2012; Dainty et al., 2001b. Other authors suggested all parties work in the spirit of respect for all and equitable team relationship (Dainty et al., 2001a; Moore and Dainty, 1999; Lichtig, 2006).

3.6.2.2 Develop and Foster Reliable Promising

Macomber and Howell (2003) highlighted the need for a balance between clearly communicating requests and reliable promising. Ballard et al. (2007) provided a detailed analysis of case studies in which reliable promising is was in the core of most of the projects. Documented case studies in the (Cheng et al., 2012; Cheng et al., 2016) report appointed reliable promising as a social strategy implemented in most of the case studies analyzed. Reliable promising increase the sense of ownership and responsibility among team members, and thus build trust.

3.6.2.3 Become a Transparent Organization

Do et al., (2015) detailed study points transparency as a key principle where finances, labor productivity and production rates are tracked and publicly displayed in accessible locations. Aims to make the workplace visual and more trustworthy. Ballard et al., (2015) propose that teams will be able to identify easily and improve underperforming areas when transparency governs in the project environment. Lichtig, 2006 projects are a network of commitments. Pishdad-Bozorgi and Beliveau, 2016b; Kim et al., 2016; Liu and Bates, 2013; Franz and Leicht, 2012; Pelberg, 2009; AIA, 2007. (Bakht and El-Diraby, 2015) suggested that transparency in projects is important to bring stakeholders on the table, facilitate flow and analysis of information.
3.6.2.4 Develop a Collaborative Mindset and Build an Integrated Culture

Lean is all about a way of thinking, a mindset by which the project is being benefited by the team as a whole (Kenig et al., 2010; Pasquire, 2012). IPD requires a shift in mindset with a focus on the best-for-project thinking and optimize the whole (Jacobsson and Roth, 2014; Mossman et al., 2010; Darrington, 2011; Lichtig, 2006; Macomber, 2005; BC Green Building Roundtable, 2007; Aapaoja et al., 2012). IPD requires buy-in from all players with a team approach (Daswani et al., 2015) and that every participant view themselves as equals (Lichtig, 2006). Walker et al., (2016) and Ghassemi and Becerik-Gerber (2011) refer a common best-for-project mindset and culture in IPD as key for allowing team members to share ideas and innovate. Kenig et al. (2010) highlights that collaboration is ultimately a behavioral choice while Cheng et al., (2012) supports willingness to collaborate as a behavioral principle. Jointly develop project success criteria (Pishdad-Bozorgi and Beliveau, 2016b; AIA, 2007). Collaborative mindset is fostered by open, direct, honest communication, and transparency among all participants (Rahman and Kumaraswamy, 2004; Love et al., 2010; Rached et al., 2014). Such collaborative mindset is supported in some way by the team’s guiding principles Do et al., (2015) of having trusted, qualified, and profitable partners, keep a creative and innovative environment, and make learning a priority. (Ballard et al., 2007) also remind us one foundation of the Toyota way: long-term thinking, as the aim is to create an integrated culture throughout the organizations, current practices need to be changed. Cheng et al., 2016 point that sharing a workspace is a critical component for building a culture. Integrated cultures require team commitment (Ibrahim et al., 2013; Sparkling et al., 2016). Matthews and Howell, (2005) recall the three musketeers philosophy: “all for one and one for all”.

3.6.2.5 Create a Safe Environment for Discussions and Promote Psychological Safety

It is fundamental in integrated projects that stakeholders feel free to speak up and share their concerns and doubts with the other members of the team (Do et al., 2015). When members speak up, they engage in conversations and begin feeling part of the team because there is a sense that they belong to the team. Yukl (2012) suggested that leaders should foster an environment with psychological safety, so people are encouraged to think outside
the box and allow creativity to flow; therefore, problems are addressed with innovation and challenges are easier to overcome. Additionally, Smith and Rybkowski (2012) pointed out that such environment can create trust and it in turns affect positively project performance.

3.6.2.6 Make Knowledge Sharing an Everyday Task

Sharing knowledge might resolve much of the potential ambiguity and make uncertainties more visual (Walker et al., 2016). In cohesive integrated teams, sharing tacit knowledge openly and early is a key for success and leads to better project performance through continuous learning (Mossman et al., 2010; Zhang and He, 2015; Zhang and Ng, 2013; Solis et al., 2013). In IPD, when working in clusters, small and diverse groups support learning and innovation and share the knowledge within other clusters (Mossman et al., 2011). By working in small batches of people, each team start optimizing the processes within their control and when working in cross-cluster teams, the whole project is optimized. Retrospective (Thomsen et al., 2010) allow the team to routinely reflect on past activities or current state and make adjustments a needed with the aim of improvement.

3.6.2.7 Continuous Improvement Through Retrospective and Learning from Breakdowns

Ballard (2000b) suggested that by analyzing root causes of projects failure, actions can be taken to prevent reoccurrence. Ballard (2008 pg. 11) said “We learn and improve performance from experiments and breakdowns. Experiments are intended deviations from standard. Breakdowns are unintended deviations from standard”. Retrospective is a technique that has been highlighted by different authors as a powerful practice for continuous improvement since it allows to think about something in specific and analyze whether something could have been different; therefore, it allows individuals to identify opportunities for improvement. Christian et al. (2014) also have noted that a way to improve current processes is by analyzing the way their work is performed and learning from breakdowns.

3.6.2.8 Make Early Involvement a Requirement

Many authors have identified the importance of early stakeholders’ involvement for improving project outcomes while defining a production system that enforce safety and
quality thinking in its definition (Khanzode et al., 2006; Mossman et al., 2011; Bal et al., 2013; Hanna, 2016; El Asmar et al., 2013; Molenar et al., 2009; Bosher et al., 2007; Kenig et al., 2010; Korkmaz et al., 2010; Cheng et al., 2016; Olander and Landin, 2005a; Kent and Becerik-Gerber 2010, Paik et al., 2017; Lapinski et al. 2006; Mollaoglu-Korkmaz, 2013; Pishdad-Bozorgi and Beliveau, 2016b; Kim et al., 2016; Lahdenperä, 2012; Moynihan and Harsh, 2015; Nawi et al., 2012; Olander and Landin, 2005; Bertelsen and Koskela, 2004; Aaltonen and Kujala, 2010; AIA, 2007; Ballard et al., 2015) and some authors (Demirkesen and Ozorhon, 2017; Rached et al., 2014; Darrington, 2011; Franz et al., 2016) identified early involvement of team members as one of the most important factors of success in IPD implementation. A key benefit of involving parties is the setting of goals and objectives with the team and agreeing on the best way to accomplish them while facilitating a common understanding of project goals to the whole pool of participants, goals are developed early, agreed upon, and respected by all (Ibrahim et al., 2013; AIA, 2007; Cheng et al., 2016; Lostuvali et al., 2014). Behm (2005, p. 608), Aapaoja et al., (2012), Christiansen (2009), and Menches and Chen (2012) also noted that it adds value when information is fed in earlier stages and it is being considered in the decision-making process and it can make the greatest impact. Construction knowledge plays an important input to support design stage, involving people at the “earliest responsible moment” facilitates this timely discussion of ideas and adopt more efficient alternatives (Ballard et al., 2015; Mollaoglu-Korkmaz, 2013; Gil, 2001; Song, Mohammed, and AbouRizk, 2009; Gane and Haymaker, 2010). It also promotes rapid feedback since construction, procurement, and operation teams bring different expertise to the table. (Cheng et al., 2012) It plays an essential principle in the target value design process because it allows an iteration of information, design ideas, and cost. It also looks for intensifying early planning. (AIA, 2007) noted that early involvement feeds information and expertise for decision-making at the right time. (Do et al., 2015; Sarkar and Mangrola, 2016; Cohen, 2010; Zhang et al., 2013; Sive, 2009; Franz and Leicht, 2012).

3.6.2.9 Standardize Co-location Practices Thoughtfully Considering Parties Impact on the Project

Fruchter, R. (2014) indicated that the most efficient interactions within stakeholders occur when they are collocated since IPD offers a space in which all disciplines work
concurrently exchanging ideas and information (Gupta et al., 2009). Physically or virtually placing team members (Aapaoja et al., 2012; Cheng et al., 2016; Walker et al., 2016; Franz et al., 2017; Mossman et al., 2010; Mossman et al., 2011; Zimina et al., 2012; Thomsen et al., 2010; Nicolini, 2002; Henisz et al., 2012; Lahdenperä, 2012; Khanzode et al., 2007; Che Ibrahim et al., 2013; Bromley et al., 2003) in a common workspace which allow for close collaboration, free exchange of ideas, better chemistry, and build team cohesiveness (Do et al., 2015; Kim and Dossick, 2011; Franz et al., 2017). The project benefits of the interaction of people with different backgrounds who identify, ask for support, become acquainted, and solve issues as a single organization (Sun et al., 2015; Kenig et al., 2010; Bulte and Moenaert, 1998; Cannella et al., 2008; Chachere et al., 2009) since it greatly affects participants’ ability to communicate with team members from different contracting parties while building familiarity and potentially grow trust between them (Cheng et al., 2012; Ashcraft, 2011a; Cleves and Gallo, 2012; Thomsen et al., 2010). When working in a single space, all decisions are easier to make, and issues are faster to be solved (Jacobsson and Roth, 2014). It is important to notice that even when co-locating teams, there is a need to ensure information flow and define ahead time when team members should be actually present on site (Ibrahim et al., 2013). Co-location is enhanced when stakeholders have a voice on how the space is formed and organizational boundaries are overcome, moreover the team can consider interdependencies or clusters for designing the space instead of a common area division between companies (Kokkonen and Vaagaasar, 2017). Cohen, 2010; Cheng et al., 2012; Nanda et al., 2016; Franz and Leicht, 2012; Laan et al., 2011

3.6.2.10 Go Share Risk and Reward in a No Blame Culture

Due the integration of cross-team, much of the uncertainty and ambiguity will be uncovered and risks allocation will be more accurate. A sharing risk and reward structure fosters collaboration and teamwork which is essential for project success and it can be considered a hallmark of IPD (Sumner and Slattery, 2010; Menches and Chen, 2012). Team success is tied to project success and risk is collectively managed and appropriately shared creating an environment where everyone aims to reach the project targets (Mossman et al., 2010; Gupta et al., 2009). Hanna, 2016; AIA, 2007; Sarkar and Mangrola, 2016; Kenig et al., 2010; Cohen, 2010; Cheng et al., 2012; Cheng et al., 2016; Pishdad-Bozorgi
and Beliveau, 2016b; Kim et al., 2016; Rached et al., 2014; Liu and Bates, 2013; Sive, 2009; Franz and Leicht, 2012. Teng et al. (2017) propose a framework of profit distribution in IPD projects based on cooperative game theory as seen in Fig. 3.4. Cathedral Hill project is an example in which risks, and their associated costs, are shared amongst team pool members and an incentive mechanism was used (Parrish et al., 2008). (Kent and Becerik-Gerber 2010 and AIA, 2007) aims to reward “what is best for project” behavior and highlighted methods for sharing risk/reward such incentive pool, innovation and outstanding performance, performance bonuses, and profit sharing.

As Sumner and Slattery (2010) highlighted, every construction project requires people with different expertise to work together. Creating a no blame culture in construction companies involves them becoming a learning organization and foster confidence and allow people to speak up and feel safe to express concerns and learn while doing. (Che Ibrahim et al., 2013; Ballard et al., 2007; Walker et al., 2016; AIA, 2007; Liker, 2004; Pishdad-Bozorgi et al., 2016; Dainty et al., 2001a; Evbuomwan and Anumba, 1998; Bromley et al., 2003).
Matthews and Howell (2005) indicate that a key characteristic in IPD team members is trustworthiness in which when mistakes occur, they don’t search for the guilty, but instead every member use their talents for the best of the project. Culture can be built through continuous reflection.

3.6.2.11 Use Collaborative Decision-Making Processes

IPD projects are expected to foster a participative process in all phases of the construction project and improve the design of the project and explore different means to achieve the project’ objectives (Tillmann et al., 2012). empowering plays a critical role in fostering a collaborative approach for decision-making since it will enable stakeholders to feel a sense of belonging and aim to be involved in discussions and look for consensus (Walker et al., 2016; Yukl, 2012). Multiple authors such as Paik et al. (2017), Hanna (2016), Kenig et al. (2010), Cohen (2010), Cheng et al. (2012), AIA (2007), Pishdad-Bozorgi and Beliveau (2016b), Kim et al. (2016), Kent and Becerik-Gerber (2010), Liu and Bates (2013), Sive (2009), Franz and Leicht (2012), Tillmann et al. (2012) also suggested that collaborative decision-making process allow the team to become more aware of what the other team members expect them to contribute to the project.

3.6.2.12 Make Design and Construction Visual

The term and concept of Virtual Design and Construction was developed by CIFE, Stanford University (Fischer et al., 2004). Simulation and visualization increase predictability of project performance and meet stakeholders’ objectives. It enables implementing an integrated approach in the project in which technology helps simulating construction processes (Khanzode et al. 2006). It helps defining a visual model considering construction sequence, means, and methods. Enabling technological capabilities and defining a visual model can assure the right process which in turn will produce the right results (Ballard et al., 2007; Zhang and Wang, 2009). AIA, 2007; Kim et al., 2016

3.6.3 Tools That Facilitate IPD Implementation

Birkhofer et al. (2002) see tools as working aids that support and facilitate the implementation of a method while Gericke et al. (2017 pg. 5) have highlighted that a tool is “an object, artefact or software that is used to perform some action”.
3.6.3.1 Last Planner System (LPS)

Last planner system increases planning reliability and production performance allowing coordination of activities and taking corrective actions to improve through constant feedback (Lichtig, 2006; Cho and Ballard, 2011; Howell, 2010; Ballard and Howell, 1994; Tommelein and Ballard, 1997; Ballard and Howell, 2004; Ballard et al., 2007; Gonzalez et al. 2008; Do et al., 2015; Ballard et al., 2007; Ballard and Koskela, 2011; Zimina et al., 2012; Thomsen et al., 2010; Fakhimi et al., 2016; Rached et al., 2014; Ballard and Howell, 2003; Alarcon and Calderon, 2003; Ballard, 2000a). It creates a predictable workflow of projects which is translated into project performance improvement by dividing a schedule into a master schedule, phase schedule, lookahead schedule, and weekly work plans (Ballard, 2000a). Hickethier et al., 2013; Nanda et al., 2016; Darrington, 2011. Also, as part of the last planner system routine, there is an everyday revision of tasks or activities for each day in short meetings called “Daily huddle meetings” (Mesa et al., 2016; Sun et al., 2015; Cheng et al., 2016; Fakhimi et al., 2016).

3.6.3.2 Target Value Design (TVD)

Target value design allows to perform a design that meet owner’s expectations based on a certain cost estimate within project constraints since it creates a project that suits the business case of the owner (Ballard and Reiser, 2004; Ballard, 2006; Ballard, 2008; Forbes and Ahmed, 2011; Ballard, 2011; Ballard et al, 2009; Ballard et al., 2007; Ballard and Morris, 2010; Liu and Bates, 2013; Naney et al., 2012; Nanda et al., 2016). The goal is to maximize value generation by enabling co-creation of value (Parrish et al., 2008; Zimina et al., 2012; Cheng et al., 2016; Thomsen et al., 2009; Oliva and Granja, 2013; Lee et al., 2010) and become design criteria in which design is agreed and developed to meet specific targets (Ballard et al., 2015; Darrington et al., 2009; Thomsen et al., 2010; Pishdad-Bozorgi and Beliveau, 2016b; Gokhale, 2011) which allow the team to agree on often complex design details and therefore minimize contingency (Mossman et al., 2011). It is applicable beyond the design phase and it helps for setting and steering to targets (Do et al., 2015; Tillmann et al., 2012). Cheng et al., 2012; Hickethier et al., 2013; Melo et al., 2013; Darrington, 2011; Macomber and Barberio, 2007. Placing the emphasis of the study in infrastructure projects, the author highlighted that previous studies have identified that PPP
projects are a viable setting for TVD (Melo et al., 2013; Sobotka and Czarnigowska, 2007; Zimina et al., 2012).

3.6.3.3 Pull or Reverse Phase Scheduling

Pull is a truly valuable principle for IPD (Sun et al., 2015) because it facilitates reliable promising and afford accountability (Seed, 2014). Cheng et al. (2016) developed a study in which participants saw pull planning as valuable with around 80% of the participants found it as “extremely effective” for project planning. Dossick et al. (2013) highlighted that pull helps identifying constraints and improve reliability and team’s integration. Nanda et al., 2016; Darrington, 2011. The idea for using pull is to provide something on the demand of the next customer to satisfy the needs downstream (Ballard et al., 2007). Also, projects often use visual reminders when pull planning, which improves communication. By using a pull approach, the team also increase the probability of having materials delivered to the site just-in-time when the project need them which is a key of success in the supply chain (Tommelein and Li, 1999).

3.6.3.4 Set-Based Design

Set-based design allows considering multiple feasible alternatives in parallel and developing a better design since it postpones committing to a specific design till the last responsible moment (Ballard et al., 2007; Macomber and Howell, 2003; Do et al., 2015; Ward et al., 1995; Ward, 2007; Sobek et al., 1999; Ballard et al., 2007; Kennedy, 2004; Morgan and Liker, 2006; Parrish et al., 2007; Kim and Dossick, 2011; Parrish et al., 2008; Lee et al., 2010; Mossman et al., 2010) avoiding later rework and wasted effort. Parrish et al. (2008 pg. 5) suggested that “Too much detail too early forces unrealistic and undesirable commitment, while too little detail may result in otherwise avoidable rework”. Hickethier et al., 2013. Mossman et al. (2010) illustrate in a very clear way in Figure 3.5 the conversation that shall happen when applying set-based design between the designer and the constructor. Such conversation aims to better define the scope of the project considering the client specific needs.
3.6.3.5 Choosing by Advantages (CBA)

Suhr (1999) said that “decisions must be based on the importance of advantages”. It helps evaluating complex decisions by analyzing the advantages and importance of each option (Cheng et al., 2016; Mossman et al., 2010; Parrish and Tommelein, 2009; Cheng et al., 2012; Lee et al., 2010). Other researchers also have highlighted the benefits of using CBA to take better decisions that are aligned with the client needs in construction projects (Do et al., 2015; Sperling, 2014; Franz and Leicht, 2012).

3.6.3.6 A3 Reports

Guides and facilitate problem solving and decision making, it helps formalizing, documenting, evaluating options, and consequent learning while reducing the loss of institutional knowledge when people move from project to project or within organizations (Gupta et al., 2009; Shook, 2008; Sobek and Smalley, 2008; Cheng et al., 2012; Do et al., 2015; Zimina et al., 2012). Thomsen et al., (2010) and Cheng et al., (2016) see an A3 as a way to engage participants in the Plan-Do-Check-Act (PDCA) thinking (Liker, 2003; Liker and Meier, 2006; Morgan and Liker, 2006). Sobek (2018) defined a sample structure for A3 reports (see Fig. 3.6) that is published in Montana State University, College of...
Engineering. He also includes useful information for individuals who has no previous experience elaborating A3 reports and users can get step by step information on the website.

Figure 3.6 Flow of a Typical Problem Solving A3 Report (http://www.montana.edu/dsobek/a3/report.html)

3.6.3.7 Onboarding Sessions

Do et al., (2015) highlights the importance for every partner attending the onboarding orientation. Cheng et al., 2016 onboarding is a way of keeping a constant training process for new members and helps in team formation, therefore, it is important that companies and project teams define and validate onboarding techniques. Seed (2014) suggested that the Integrated Project Manager is the one responsible of creating onboarding curriculum and schedule training for new members.
3.6.3.8 Study Action Teams (SAT)

When first launch, study action teams might create the spaced where people bring ideas and opinions while getting familiarize with new concepts, principles, and tools (Hill et al., 2007; Ghassemi and Becerik-Gerber (2011)). The main objective is to create a learning culture where people listen to and respect each other’s perspectives and later create a shared mind team with deep and strong relationships (Lichtig, 2007). In this environment people feel empowered. People learn from reading books and team discussions. Macomber and Howell (2005) see SAT as a collaborative, supportive team and a vehicle for continuous improvement which will transform and improve organizations.

3.6.3.9 5 Whys

The tool 5 whys is a systematic approach which help learning from breakdowns or learning from failures (Fischer et al., 2014; Mesa et al., 2016; Do et al., 2015; Ballard et al., 2007; Cheng et al., 2016). This tool aims to help team members identifying root causes and work to mitigate issues before occurring.

3.6.3.10 First Run Studies (FRS)

First run studies help prototyping production processes to better understand them and find potential opportunities of improvement (Mesa et al., 2016; Do et al., 2015; Ballard et al., 2007; Fakhimi et al., 2016; Ballard and Howell, 1997). Liker (2004) and Knapp et al. (2014) complemented the overall idea with “go and see for yourself” thinking in which participants do Gemba walks and go to the site, analyze what is going on and identify potential issues and take actions for improvement.

3.6.3.11 Value Stream Mapping (VSM)

Researchers have highlighted value stream mapping as a visualization tool, it allows understanding the processes and identification of value and hidden waste, it also help when standardizing common processes (Cheng et al., 2016; Do et al., 2015; Thomsen et al., 2010; Ballard et al., 2007; Hazelton et al., 2008; Hickethier et al., 2013; Franz and Leicht, 2012). Also, it has proven its effectiveness for reducing lead times. Liker (2004) noted that by making projects more visual, no problems are hidden.
3.6.3.12 Visual Controls

It allows the team to visualize the project and better understand how it will be built over time while improving product and processes by using BIM or visualization tools (Cheng et al., 2016; Kenig et al., 2010; Do et al., 2015; Cheng et al., 2012; Mossman et al., 2010; Ballard et al., 2007; Clayton et al., 2002; Franz and Leicht, 2012) such as Revit, NavisWorks, CommonPoint Project 4D, iRoom (Koo et al, 2000; Shreyer et al., 2002). It provides accurate input for planning everyday actions and allows team members to clearly understand how the project will be constructed. It is also included under this category basic tools such dashboards (Cheng et al., 2016).

3.7 Conceptual Framework for Facilitate IPD Implementation

The conceptual framework proposed is one that tries to fully capture the essentials of IPD and guide practitioners throughout the implementation of such integrated approach. It includes three different layers of use which are represented in Figure 3.7. All layers are connected and reinforce each other into the implementation process. The successful implementation of such framework can be achieved because the conjunct effort of all players or buy-in of the process. It should be interpreted as a guideline for implementing an integrated approach that would enhance the overall project rather than a list of ideas that can improve parts of the process.

![Figure 3.7 Layers of the Conceptual Framework Proposed in the Research](image-url)
3.7.1 The Project Team

The project structure of an IPD project might change according to the scope of the project and the size of the organizations involved. Figure 3.7 and Figure 3.9 show a summary of the different governance structures in an integrated project such as the IPD leader, cluster teams, core group, and the senior management team. Both figures aim to help readers understand how one group integrates the others in some way, showing the high interdependency between project stakeholders.

Figure 3.8 Project Governance Structure in IPD Teams (After Do et al., 2005. "The Application of Target Value Design in the Design and Construction of the UHS Temecula Valley Hospital")
As seen in Figure 3.9, the IPD leader is responsible to develop the other individual team members in the project. Also, cluster teams are often composed by IPD leaders who work on a specific topic and try to solve one problem in the project. It can also be seen in such figure a summary of the main functions of cluster teams in a project.

Figure 3.9 Governance Structure for IPD Projects

3.7.2 Principles for Facilitating IPD Implementation

Projects using IPD are expected to intrinsically present the following principles (Fig. 3.10) all throughout the execution of the projects. Figure 3.10 includes a summary of all the principles found through the systematic literature review. Such principles shall be implemented in projects according to the specific needs for each project. Measuring and
establishing a baseline for organizations is needed because the principles proposed might be implemented to some extent in each organization; therefore, efforts can be redirected to where it is more needed.

Figure 3.10 Principles that Build and IPD Culture

3.7.3 Tools for Facilitating IPD Implementation

Projects using IPD employ multiple tools to facilitate implementation of IPD even when the level of awareness about these tools as part of IPD is very low. The results shown in Figure 3.11 support what the researcher have observed during site visits in companies with high expertise in IPD in the USA. Studies suggests that tool such as co-location, on-boarding, A3, and CBA can potentially impact a successful implementation of IPD in projects (Cheng 2016). However, there is generally a lack of knowledge in different projects about tools available for use in the projects. There seems to be considerable opportunity to start using the IPD tools introduced in this chapter and making people aware of its existence and impact is a start. It is important to highlight that here is also a need to establish certain processes to begin such desired change, for example introducing on-boarding sessions for the whole team would help improving the first interaction between individuals and the project team.
### 3.8 Summary and Discussion

Integration is urgent in the light of more new specialist disciplines emerging and the engagement of participants in earlier stages of the project. It has been proven that IPD is capable of enhancing the delivery of projects in terms of project performance, sustainability, and work environment at the individual, team, and organizational level. Therefore, IPD has attracted attention from the AEC industry and it is key to assure its successful implementation to improve project delivery. Primary data for the study was collected through a systematic analysis of the existing body of knowledge in phase 1 in a conceptual framework for IPD implementation. The conceptual framework proposed by the author captures the main principles, tools and an advisable governance structure that should govern an integrated project and facilitate the implementation of such delivery method.

Given all the work that has been published from academia and practitioners, there is a need to summarize how IPD had been implemented to guide new markets such Peru in the process of acquiring this integrated approach in construction. Authors such Forero et al. (2015) studied IPD applicability in a country with similar characteristics in construction, Colombia, stating that major stakeholders in construction had shown interest in adopting more collaborative approaches in construction to deliver projects more effectively.

![Tools that Facilitate IPD Implementation](image)
Therefore, a question arises regarding the willingness of stakeholders in Peruvian construction industry to adopt changes required to implement and sustain IPD projects. The principles and tools summarized in this research are not limited but the most commonly applied among practitioners. Over time and as the research evolves, the proposed framework will be modified as per the practice suggested because empirical evidence will be added to demonstrate the effectiveness or potential areas for improvement in the conceptual framework proposed.

### 3.9 Conclusions

Chapter 2 gave a very solid fundament for applying IPD to improve the delivery of complex infrastructure projects. In chapter 3, the study presents a deep analysis of the psychological factors that enable IPD implementation along with a guideline that includes principles, tools, and governance structure that facilitates IPD successful implementation.

IPD in practice section is divided into the three layers that form part of the conceptual framework proposed by the author. First, IPD’s shared governance structure is presented. Shared governance involves the way a project structure is set (the people), how the profit is being distributed (the money), and how decisions are being managed in the integrated team (the responsibility). Second, IPD principles governing integrated projects are presented. The principles were found through the literature review in which the coding word looked was “principle” for analyzing the information available. The principles presented are not exclusive and more principles can be added, or the ones presented can be modified with further studies. Third, tools that facilitate IPD implementation are also introduced briefly. It is important to notice that the objective of the author was not to emphasize the analysis of each specific tool, but rather present a brief description of the more relevant findings from the literature review.

The next chapter 4 will analyze the application of the framework in chapter 3 section 3.4.
4. APPLICABILITY OF THE PROPOSED CONCEPTUAL FRAMEWORK

4.1 Introduction

The author previously studied the current state of integrated project delivery (IPD) in the world and proposed a framework to build IPD principles and implement IPD tools within a specific project structure that would make IPD more suitable. This framework is compared and contrasted with the current state of practice in the Peruvian construction industry with an emphasis on infrastructure projects. A case study will now be used to further analyze the applicability of certain principles and tools from the framework and determine future steps for improvement in Peru over the next 15 years.

4.2 Literature Review

4.2.1 Complexity in Construction

Architecture, engineering, and construction (AEC) companies have been failing to meet the project owner’s performance expectations or customer requirements, resulting in the disruption of progress for a given project (Lichtig, 2006; Ballard et al., 2007). Due to traditional methods in construction, a number of issues such as rework, time delays, higher costs than expected, a lack of understanding, and poor support plague the construction sector (Nawi et al., 2014a). As a consequence of these numerous issues, productivity in construction has been decreasing over time, Changali and van Nieuwland (2015), from McKinsey and Company, used data from the World Input-Output Database (WIOD) to provide an overview of the decrease in construction productivity that has occurred (McKinsey & Company, 2015). According to some researchers, poor project performance and client dissatisfaction can be attributed to different causes such as fragmentation or “the silo effect” that obstructs coordination and integration in construction operations (Paik et al., 2017; Walker et al., 2016; Xue et al., 2005; Harper, 2016) from the point of project conceptualization till the operation and maintenance of newly built facilities. In addition, the lack of leaders who understand and are willing to commit to new systems means that companies are failing to get the best performances from a project’s team members.
(Fernandez-Solis et al., 2013), and other causes regarding human behavior have been advanced as well, many of which further highlight the lack of coordination and integration in the industry. Similar issues have been reported in the Peruvian construction market: issues linked to the lack of integration and the misalignment of goals between stakeholders (Canales 2014).

Lately, due to the collective relationships between different stakeholders and the competitive budgets and schedules involved, construction projects are often seen as complex undertakings (Nawi et al., 2014a; Palacios et al., 2011). The process of designing, constructing, and operating new facilities and the interactions between the different stages are particularly complex (Wood and Gidado, 2008). Ballard et al. (2007) have highlighted how over time there has been a trend of projects changing from being simple, certain and slow to being more complex, uncertain and quick. The construction industry over the years has been described by many authors (Mills, 2001; Aapaoja, 2013; and Zhang et al., 2013) as one of the most dynamic, risky, with high uncertainty, and challenging industries. Construction projects are unique in its kind and full of uncertainties (Liu 2013); therefore, dealing with such high levels of risks and uncertainties requires effective cross-team collaboration between all project participants involved is required to successfully deliver a project (Walker et al., 2016). Complexity requires an integrated approach, which is achievable in an integrated project delivery (IPD) environment (Demirkesen and Ozorhon, 2017). IPD was developed to address the challenges presented by the increasing complexity of construction projects and aims to foster a culture where collaboration is embedded in all individuals involved (Bilbo et al., 2015; Sun et al., 2015).

As complexity and uncertainty increases in projects, according to Zhan and Wang (2009) more effort is required in early stages of projects since the ability to impact cost and functionality is higher earlier in the project. Seed (2014) also suggested that the most impactful time to improve the project is during design.

### 4.2.2 Infrastructure Projects and Potential Application of IPD in Peru

Changali and van Nieuwland (2015) from McKinsey & Company wrote a report called “The Construction Productivity Imperative” in which they projected that global investment in infrastructure projects would double in the next 15 years. The report used data from
public annual reports from various companies that were published in the IHS Herold Global Projects Database, and the researchers estimated that around 98% of megaprojects suffer cost overruns of at least more than 30% the original cost while deviating from the original schedule by falling an average of 20 months behind.

During the ’80s and ’90s, Peru suffered an economic crisis that limited investment in infrastructure projects (World Bank, 2017). Consequently, the public construction sector slowed down and traditional delivery methods such as DBB and DB prevailed in the Peruvian market (Medina, 2014). This was similar to the situation in other Latin American countries such Colombia where DBB is also the traditional delivery method of choice (Forero et al., 2015). According to a report from the national institute of statistics and informatics from Peru (2016), today, the Peruvian economy is growing constantly with an average steady growth in the construction sector of 9.7% per year in the last decade. However, the construction industry has been slow to respond to changes and continues to uphold traditional processes that are characterized by the same slow, tedious processes and practices linked to traditional approaches. This has been occurring despite the fact that the need for investment in infrastructure projects is very high, so there is a need for a change in practices to better respond to the current climate in the industry.

For example, as Bonifaz et al. (2015) highlighted, more than 25% of people in the Peruvian population do not have access to drinkable water. Furthermore, as shown in Figure 4.1, there is a need for further investment in building projects for the transportation, healthcare, energy, telecommunications, and education sectors, with an estimated cost of up to $1.6 billion (USD) to meet those needs (Bonifaz et al., 2015). As a result, efficiency in the construction sector is of critical importance for the nation since it is this sector that provides infrastructure development.
Figure 4.1 Infrastructure Gap in Peru (after Bonifaz et al., 2015, "A Plan to Get Out of Poverty: National Infrastructure Plan 2016-2025", AFIN)

Infrastructure projects involve a wide range of organizations that must work together and deal with large and complex tasks; therefore, a collaborative delivery method is needed due its ability to support people in managing the high levels of complexity and risk involved (Love et al., 2010; Walker et al., 2015; Lahdenperä, 2012). Also, Levitt (2007) points out that infrastructure development requires a different project structure from traditional approaches that can foster integrated project governance such as private-public partnerships, which work reasonably well. The complex nature of infrastructure project construction renders them ideal candidates for implementing an IPD approach.

### 4.2.3 Collaborative Models for Sustainable Changes

The study follows a combination of Kotter’s (2002) process for making sustainable changes (see Fig. 4.2) and one of Kennedy’s (2003) methods for implementing major changes. The participative model is found in the book *Product Development for the Lean Enterprise* (Kennedy, 2003) and was created to develop a sustainable IPD culture. Adopting an IPD culture requires full commitment and perseverance from the team members involved (Aapaoja et al., 2012; Walker, 2002; Hoezen, 2012; Hellmund et al., 2008). According to Kotter (2002), more than 50% of efforts fail in the first step of the eight-step process, which includes the identification of the need to change and motivations...
for changing. Therefore, organizations adopting IPD for the first time should establish very good reasons for changing and devote major effort at the beginning of the process to overcome such obstacles and attain people’s commitment.

To create a sustainable change in the organizations, Kotter (2002) in his book “The heart of change”, suggested an eight-step process shown in Fig 4.2 in which he offered a clear guideline for pursuing sustainable changes.

While Kotter (2002) proposes an eight-step process to manage organizational cultural change at any level in an organization, Kennedy’s (2003) participative model complements Kotter’s model by suggesting that leaders should define the goals and highlighting the importance of engaging the team members who are responsible in defining the path to achieve the set goals. Kennedy’s (2003) process involves working in groups and fostering collaborative decision-making, which accelerates the sense of ownership and buy-in among team members.

<table>
<thead>
<tr>
<th></th>
<th><strong>Create a sense of urgency</strong>: People willingness to say “Let's go, we need to change things” improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><strong>Pull together a guiding team</strong>: Made up of the right people and demonstrate teamwork</td>
</tr>
<tr>
<td>3</td>
<td><strong>Create clear, simple, uplifting vision</strong>: Set strategies and direct action in the right direction</td>
</tr>
<tr>
<td>4</td>
<td><strong>Communicate the vision through simple, heartfelt messages</strong>: Accelerate people buy-in and make the vision a reality</td>
</tr>
<tr>
<td>5</td>
<td><strong>Empower people</strong>: Remove barriers for facilitating people move forward once they begin to understand and act on changes</td>
</tr>
<tr>
<td>6</td>
<td><strong>Create short-term wins</strong>: Foster victories that nourish faith emotionally rewarding team members and build momentum</td>
</tr>
<tr>
<td>7</td>
<td><strong>Maintain momentum</strong>: Simple courage and perseverance help. Rethink activities, delegate up, down, and sideways</td>
</tr>
<tr>
<td>8</td>
<td><strong>Make change stick</strong>: Nurture and embrace the new culture which means the behavioral norms and shared values</td>
</tr>
</tbody>
</table>

Figure 4.2 Summary of Kotter’s (2002) Model for Making Changes Sustainable
4.2.4 Summary State of the Art

AEC industry is plagued with issues such as rework, time delays, higher costs than expected, a lack of understanding, and poor support between stakeholders. Numerous researchers support the idea that such issues were caused mainly due to fragmentation in construction. Fragmentation does not only account for the different stakeholders working individually, but it also involves the misalignment of goals and objectives of people working in a single team building a project. In addition, since project complexity has been arising, more players are involved in the construction of a given project which in turns make projects even more undertaking. Projects uniqueness adds complexity and uncertainty. Under such scenario, IPD has emerged as a potential solution that would mitigate current challenges in construction by fostering the implementation of certain principles, the use of tools that would facilitate such implementation, and the unification of a team that works under a project governance structure that accommodates better a collaborative environment in the project. Researchers have also suggested that in order to improve project delivery, more effort should be devoted to early stages in a project since early stages are often the most impactful time to improve.

Moreover, previous research show that infrastructure projects are among the most complex projects being built due to their scope and particular characteristics. As complex projects, the construction of infrastructure projects has been characterized for suffering of cost and schedule overruns. Traditional delivery methods such DBB and DB have prevailed in the public sector in countries such Peru. However, it is projected a high investment for projects in the public sector in Peru. Such investment need to be directed in the best possible way and IPD offer such focus on customer and end users while trying to optimize the betterment for the team and the betterment for the project. IPD as a delivery method is an ideal candidate for managing the high complexity of building infrastructure projects in Peru; therefore, the applicability of the conceptual framework proposed in the previous chapter will be tested in this chapter.
4.3 Research Statement and Objectives

4.3.1 Research Statement

Integrated Project Delivery (IPD) has proved its effectiveness and the benefits it has as a delivery method for construction projects, yet it has not been used in Peru. The implementation of IPD varies from project to project in terms of the tools being used as well as the principles fostered in such projects, therefore the author developed a general guide for a proper implementation of IPD. The thesis of this research is that successful implementation of IPD guided by the conceptual framework proposed in this research will enhance the delivery of infrastructure projects in Peru in terms of metrics such customer relations, safety, schedule, cost, quality, financial metrics, communication, and collaboration due to IPD’s potential for dealing with highly complex projects.

4.3.2 Objectives

Chapter 4 aims to provide readers the findings of two insightful analysis developed in the study. The objective for the first analysis which in presented in section 4.8 is to present the findings of a sample case study of a company that is trying to implement IPD for the first time in Peru. The objective of the second analysis developed in this chapter in section 4.9 is to expand the analysis of the conceptual framework applicability for the Peruvian construction industry in different paths of knowledge. After analyzing both sections, the author worked along with LCI Peru on proposing potential actions for facilitating IPD implementation and improving construction industry. Other objectives are:

- Understand what principles and tools had been applying in the case study in its process of implementing IPD in an infrastructure project.
- Get to know the importance of LCI Peru community of practice in making IPD implementation sustainable.
- Role of facilitation workshops and training programs in developing Lean leaders to guide the industry towards collaboration.
4.4 Methodology

Chapter 4 presents findings from phases 2 and 3 of the research along with a deep analysis on the findings and a proposed plan of action for improvement. Figure 4.3 highlights phases 2 and 3 and each of them is briefly described below in order to help the reader understand where the findings presented in this chapter came from.

- **Phase 1**
  - **Systematic Literature Review**: Understanding how IPD has been successfully implemented. **Determine what works and what does not work.**

- **Phase 2**
  - **Case Study**: Current state of construction practices in one of the largest construction companies in Peru allow to analyze insights of an infrastructure project in Peru. Understand participant’s expectations and motivations.

- **Phase 3**
  - **Survey**: Individual assessment to set journey to continuous improvement in the Peruvian industry that lack of expertise in IPD.

**Figure 4.3 Methodology for Analyzing Proposed Framework Applicability**

In phase 2 for the case study, the author visited the project under analysis to visualize certain practices such as the use of visual aids in the field and participate of certain meetings such as last planner meetings. Visits were conducted every three months while the author visited Peru to gather data for the research. The research started as a collaborative effort to present the effort that had been done to use IPD as a delivery system by the sample company under analysis in the LCI Congress in California in 2017 were the author and one representative of the company presented the first findings of the research regarding the sample case that was analyzed and reported in this study. The author used data from the phase 1, the systematic literature review, to develop a survey that was distributed through LCI and aim to answer questions regarding the applicability of IPD in such company that was the only case in Peru found till the moment of the study. Phase 3 on the other hand aims to expand and generalize the study to the Peruvian construction industry with a focus
on infrastructure projects. More general questions were included in this phase, also the author used LCI paths of knowledge to better identify where improvements should be done and set a plan of action accordingly.

4.5 Case Study Description

In 2017, a group was formed by an infrastructure company that acts as an internal client for the group; the group is comprised of a general contractor, an operation and maintenance company, an engineers and designers company, and general services company. The project for this case study is ongoing, and its scope covers the expansion of one of the biggest infrastructure projects in Peru. The project (Fig. 4.4) is focused on the expansion of an existing infrastructure project (in the transportation sector) with an investment of more than $410 million USD. As a contribution to the body of knowledge, the case study serves to current state of construction practices in Peru and to compare it with the proposed framework. As a part of the case study in the company, the author focused on what is being called in the research as “Project A” because it represents the first attempt to date at applying IPD in the country. Design and pre-construction services started early in 2016, and the project is currently under construction with a planned end date of the end of 2018. The team sought not to directly think about the profit for each company involved, but rather to align all efforts to generate greater value and accomplish the overall goal of the group with the motivation of continuing on the path of becoming one of the leaders in the sector. As a team, they started working on creating collaborative channels to improve all project phases and reduce the expected project costs while successfully delivering the final product.

Figure 4.4 Perception of the Level of Complexity for Infrastructure Projects
The author used the results of a questionnaire as part of the case study that were distributed through LCI Peru. The survey collected data regarding the use of specific tools such Target Value Design (TVD) and Last Planner System (LPS) among others. All respondents are professional who have been involved in large-scale projects. The author, through LCI Peru, originally intended to gather information about the different disciplines of the respondents who were spread throughout the organization. But for confidentiality reasons, they have not been individually identified in this study.

The company under study in phase 2 is at the moment the only one in the country that have intended to use IPD as delivery method for one of its projects. Therefore, by understanding construction practices present in the case study and the principles and tools presented in the conceptual framework, the author identifies the gap between the best practices in a sample company in Peru in its way of using IPD and the ideal state shown in the framework. Additionally, in phase 3 of the research and to expand the findings into the Peruvian construction industry, the author analyzed findings of a broaden questionnaire developed by LCI Peru and sent to corporate members of the organizations regardless of their level of involvement with Lean and the lack of expertise on IPD participants might have had. The objective was to better identify paths for improvement based on current practices in Peru and then provides a plan with suggestions for improvement. The improved model for IPD implementation has been developed by considering feedback from the academic advisors and representatives from LCI Peru academic committee through monthly sessions where results of the surveys were discussed along with the framework presented by the author.

4.6 Level of Complexity in the Infrastructure Division

The focus of the study relies on the potential implementation of IPD for infrastructure projects in the form of PPP which have a certain level of flexibility on the delivery of public projects (Robinson et al., 2010). Integration between parties can take on different shapes as a project’s complexity and uncertainty increases (Mitropoulos and Tatum 2000). The case study included a survey that had a question with a Likert scale rating between 1 to 5 to measure the respondents’ perception of a project’s complexity (1: very low complexity, 2: low, 3: medium, 4: high, and 5: very high complexity). This question was included to
confirm the assumption that infrastructure projects are highly complex. It seems likely that high complexity can either motivate and encourage people to perform better or demotivate them should they think that the tasks are far too great for their capabilities. Furthermore, the perception of the level of complexity involved might trigger changes in behaviors best describe by the statement, “This is how I’ve always done it” (Fernandez-Solis et al. 2013). When analyzing the results of the study, the author found that the participants of the case study reported that the projects (all from the infrastructure division) they had worked on all had medium to high levels of complexity with around 42% of participants believing that their projects were highly complex (as shown in Figure 4.5). It has been argued that increased complexity in projects requires collaborative and creative behaviors in order for the outcomes to be successful (Ballard et al. 2011). Further, the IPD delivery system has demonstrated its capabilities in dealing with complex projects (Cohen, 2010; Mesa et al., 2016; Ballard et al., 2011). However, there questions remain about how to promote the desired behaviors.

![Figure 4.5 Perception of the Levels of Complexity of Infrastructure Projects](image)

### 4.7 Current State of Lean, BIM, and IPD Knowledge

The study also analyzed the level of familiarity the participants had with Lean, building information modeling (BIM), and IPD. The results for each category are shown in Table 4.1. Given that the company in the case study has been implementing Lean construction for some years, most of the participants (93% = 24 out of 26 people) were familiar with Lean and used it to some extent. On the other hand, around two-thirds of the participants...
were familiar with the concept of IPD or had only heard about it. Therefore, to encourage its successful adoption in the new market, training would play a crucial role.

Table 4.1 Participants Knowledge of Lean, BIM and IPD within the Participants

<table>
<thead>
<tr>
<th>Answer</th>
<th>LEAN</th>
<th>BIM</th>
<th>IPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>93.3 %</td>
<td>73.3 %</td>
<td>40.0 %</td>
</tr>
<tr>
<td>A little bit</td>
<td>6.7 %</td>
<td>20.0 %</td>
<td>26.7 %</td>
</tr>
<tr>
<td>No</td>
<td>0.0 %</td>
<td>6.7 %</td>
<td>33.3 %</td>
</tr>
</tbody>
</table>

![Figure 4.6 Current State of Knowledge Regarding Lean, BIM, and IPD in Peru](chart)

The result shown in Figure 4.6 was driven by the low diffusion of collaborative delivery systems in the Peruvian construction industry. The result is also supported by Forero et al. (2015), who developed a study that explored perceptions of and dispositions toward IPD in Colombia, a neighboring country of Peru with similar characteristics in construction practices. Forero et al. (2015) found that around 66% of participants in the study knew about BIM, 64% knew about Lean construction, which suggested that both concepts are more popular than IPD in Colombia.

4.8 Analyzing IPD’s Applicability in a Peruvian Case Study

The study focuses on current construction practices applied in Peru; therefore, not all the tools and principles in the conceptual framework were analyzed, only those most relevant
and common in the Peruvian sector. IPD projects operate based on the set of principles and tools included in the conceptual framework proposed in chapter 3. Companies employ such principles and tools to facilitate IPD implementation even when the level of awareness about IPD itself as a concept is very low. The results shown in this section support what the author observed during site visits to the company and the data gathered from the first survey conducted as part of the case study in the company. The first survey was structured to capture the implementation intensity of certain principles apply in Peru.

4.8.1 IPD Principles Applied in the Case Study

The study aims to analyze the applicability of some of the IPD principles identified in chapter 3. Analyzing the applicability of such principles illustrates the gap between the current state of construction practice in Peru and the ideal state of IPD projects while providing views to potential areas of improvement in specific areas. Fostering an integrated environment in projects require intimate and genuine collaboration among and across teams because every individual contribute to the project disseminating knowledge gained from previous experiences.

4.8.1.1 Developing a Culture of Respect and Trust and Fostering Reliable Promises

Principles 1 and 2 of the conceptual framework are analyzed by first identifying what factors participants perceive as important or fundamental for successful IPD implementation. In addition, the author also studied the main elements the project team considered when choosing project partners.

The author aimed to elicit the opinion of respondents about key factors to achieve an integrated project and successful project delivery. Participants were given a multiple-choice question with a set of predetermined options and the ability for respondents to include their own. A summary of their responses is presented in Figure 4.7. Surprisingly, respect was the lowest-rated factor, which suggests the need to change the current mindset regarding core values. However, this answer could have also been received due to a misunderstanding of the question’s objective from the respondents, which might be a possible explanation for why one of the participants stated during a site visit that respect was already implicit in the way they behave, so it was not seen as a separate principle or a
separate factor of success. Meanwhile, the author also highlighted the culture of survival that might still be governing Peruvian construction such in the sample case study analyzed in the research. Individual behavior and thinking might limit integration and therefore competitiveness. IPD has the potential to lead to cultural change through a more collaborative mindset since it requires new ways of behaving and thinking to get rid of old habits (Aapaoja et al., 2013; Ballard, 2008; Pishdad-Bozogi, 2016; Suttie, 2013). In a scenario such as the case study analyzed where survival is more important than working conditions, there is a need to go back to the basics, revise the main principles being followed, and always keep in mind that Lean requires respect.

Trust is at the heart of collaboration (Ab Aziz et al., 2011) and it needs to be built and maintained. Trust increases the potential to achieve mutual objectives.

More than half of the participants agreed that communication, commitment, mutual benefit, and shared governance are key factors for successful IPD implementation as a delivery method for construction work in Peru. However, the author wants to emphasize that such factors are in reality just as important as the lowest-rated factors of respect and leadership when it comes to successfully working on complex projects with large numbers of parties involved.

![Figure 4.7 Participants’ Perception about Essential Factors for Successful IPD Implementation](image-url)

Figure 4.7 Participants’ Perception about Essential Factors for Successful IPD Implementation
Cost was the most relevant factor that project stakeholders in construction projects identified as enabling the scope of a given project. However, the author found that the project team did consider aspects other than cost as well when choosing key partners even though cost would be seen as the key consideration with traditional delivery methods. Some of the other factors the team considered were technical proposal, design, expertise, and interviews.

Highly complex projects very often carry high risks and it requires companies to be knowledgeable in the subject area so that they can better solve problems creatively and deal successfully with any project challenges. In Figure 4.8, the author presents a graph of the main drivers that the participants consider when selecting key partners for the project under study with 26 participants who responded to the questionnaire. The results show that cost is still the main driver for choosing key partners in the case study but that technical proposal and expertise also play an important role.

When dealing with complex projects such as Project A, a diverse set of people need to be involved in the team so that more creative solutions can potentially be found to deal with the high level of project complexity. In Project A, $9 million USD was at risk; therefore, converting risks into opportunities was considered necessary for all parties. Hill et al. (2007) argue that the success of a team depends on the proper selection of participants, the establishment of goals and plans, skillful facilitation, and the engagement of all participants.

![Figure 4.8 Factors Considered When Choosing Partners in the Case Study](image-url)
“IPD calls for a best value selection” as it demands strong commitment and collaboration from the project partners (Ghassemi and Becerik-Gerber, 2011). Zimina et al. (2012) suggested that ideally selection of the team should be based on interviews, experience in similar projects and their desire to adapt to lean. Also, Pishdad-Bozorgi and Beliveau (2016b) suggested that IPD projects select the project partners based on qualifications which includes technical proposal, design concept, similar experience and interview performance. Sumner and Slattery (2010) state it is worthwhile to consider selecting individuals who have demonstrated that they can work well in teams with some sort of training focused on team-building.

For more accurate and precise selection of key partners, the tools discussed in section 4.5.2 such as choosing by advantages (CBA) and A3 reports could help the team take more informed decisions based on how advantages of the project can be applied.

Specific questions from the case study regarding the idea of building trust and respect and the recognition that IPD is a different way of doing things are presented in Table 4.2 The author used a Likert scale with ratings between 1 and 5 to measure progress with regard to building trust and respect. Statements 1 and 2 from Table 4.2 show that more than half of the participants (13 people) acknowledge IPD as positive for creating a new environment with trust; however, participant lack of knowledge regarding IPD might have prevented more support for these first two statements since it is clear that not all participants were aware of IPD’s benefits for individuals or organizations. On the other hand, statements 3 and 4 aimed to assess whether there are good relationships and a certain level of equality among teams and partners, but the results show that there is room for improvement since only 15% and 30% of participants rated statements 3 and 4, respectively, with 5 points. Additionally, statements 5, 6 and 7 represent the participants’ sense of belonging and ownership of the project. The last three statements received a score of 4 or 5 from around 80% of participants, which provides further motivation for IPD implementation since participants feel that they are essential parts of the teams they belong to and are capable of making big changes.
Table 4.2 Answers in the Case Study Regarding Building Trust and Respect

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IPD is a different way of doing things.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>23.08%</td>
<td>46.15%</td>
<td>23.08%</td>
<td>3.77</td>
</tr>
<tr>
<td>2</td>
<td>IPD helps to create trust.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>15.38%</td>
<td>38.46%</td>
<td>38.46%</td>
<td>4.00</td>
</tr>
<tr>
<td>3</td>
<td>Every member is well represented (between teams and partners).</td>
<td>7.69%</td>
<td>0.00%</td>
<td>30.77%</td>
<td>46.15%</td>
<td>15.38%</td>
<td>3.62</td>
</tr>
<tr>
<td>4</td>
<td>My relationship with other companies of the group is good.</td>
<td>7.69%</td>
<td>7.69%</td>
<td>7.69%</td>
<td>46.15%</td>
<td>30.77%</td>
<td>3.85</td>
</tr>
<tr>
<td>5</td>
<td>I can make big changes.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>53.85%</td>
<td>38.46%</td>
<td>4.15</td>
</tr>
<tr>
<td>6</td>
<td>I feel empowered.</td>
<td>7.69%</td>
<td>7.69%</td>
<td>15.38%</td>
<td>38.46%</td>
<td>30.77%</td>
<td>3.92</td>
</tr>
<tr>
<td>7</td>
<td>I am an essential part of the team.</td>
<td>0.00%</td>
<td>15.38%</td>
<td>7.69%</td>
<td>30.77%</td>
<td>46.15%</td>
<td>4.08</td>
</tr>
</tbody>
</table>

4.8.1.2 Increasing Transparency in the Project

It is critical in building trust among teams to encourage transparency and clarity in delivering and sharing information. Statement 1 in Table 4.3 shows that 15% of participants do not feel that the project objectives are always clear and understood by all parties. In order to increase transparency in the project it is also important to understand what the other parties want and what their expectations are. Therefore, working on sharing other team members’ expectations is key. As seen in statement 2 in Table 4.3, the rates are
relatively low compared to previous results, with an average rating of 3.46 out of 5, which means that it is necessary to create mechanisms to properly share and understand other parties’ expectations. This finding should be included in the conceptual framework.

Table 4.3 Answers in the Case Study Regarding Clarity

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project objectives are clear and understood by all parties.</td>
<td>0.00%</td>
<td>0.00%</td>
<td>21.43%</td>
<td>64.29%</td>
<td>14.29%</td>
<td>3.93</td>
</tr>
<tr>
<td>2</td>
<td>I understand other companies’ expectations.</td>
<td>7.69%</td>
<td>7.69%</td>
<td>23.08%</td>
<td>53.85%</td>
<td>7.69%</td>
<td>3.46</td>
</tr>
</tbody>
</table>

4.8.1.3 Developing a Collaborative Mindset and Fostering an Integrated Culture

Walker et al. (2016) highlighted that intimate collaboration among project parties provides more accurate predictions of project performance and facilitates the solution of problems that might arise over time. An IPD collaborative mindset involves a set of practices that include collaborative goal setting, looking for the best outcomes for the project, and the alignment of individual interests to accomplish common goals. The study identified the stakeholders who participated in setting the goals for the project, and the results show (Figure 4.9) that all stakeholders were involved in goal setting according to the participant’s perception (26 participants). The most involved parties are the client, the general contractor, and the architects and designers of the project. Such parties participated a great deal in setting the project’s goals; however, it is also important to highlight that other important parties when it comes to building infrastructure projects include the MEP contractor, structural contractor, and civil contractor. These three participants also have a big impact on complex infrastructure projects and therefore are involved in goal setting.
Building an integrated culture requires the commitment of all participants and the alignment of project participants to achieve the best outcomes for the project. As seen in Table 4.4, team commitment as presented in statement 1 has an average rating of 4.25 out of 5, meaning that there is a relatively high commitment to solving problems for the betterment of the project. In addition, statements 2, 3, 4, and 5 are related to overall understanding of the project’s success metrics and the alignment of individual stakeholders’ interests to achieve the project objectives. The first three statements here have a consistent rating of about 4.00 points out of 5. Meanwhile, statement 5 sees the rate drop to 3.71 out of 5, which raises questions about team member commitment to accomplish common goals. Consequently, agreement and alignment on project objectives is working well with some options for improvement; however, the commitment to achieve common goals still needs to be reinforced.

Statements 6, 7, and 8 are related to teamwork and how individuals benefit from working as teams or how teams benefit from individuals using integrated thinking. Statement 6 confirms the recognition that most participants feel that they work better as teams. However, statements 7 and 8 have lower rates which means that teams are struggling with integrating new members. In such instances, onboarding sessions might help mitigate such issue and improve the inclusion of new people to a team.
Table 4.4 Answers in the Case Study Regarding Integrated Culture

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is the team committed to solve problems for the betterment of the project instead individual interests?</td>
<td>0.00%</td>
<td>0.00%</td>
<td>6.25%</td>
<td>62.50%</td>
<td>31.25%</td>
<td>4.25</td>
</tr>
<tr>
<td>2</td>
<td>I understand the project’s success metrics.</td>
<td>6.25%</td>
<td>6.25%</td>
<td>0.00%</td>
<td>56.25%</td>
<td>31.25%</td>
<td>4.00</td>
</tr>
<tr>
<td>3</td>
<td>All stakeholders agree and are aligned with the objectives of the project.</td>
<td>0.00%</td>
<td>0.00%</td>
<td>21.43%</td>
<td>57.14%</td>
<td>21.43%</td>
<td>4.00</td>
</tr>
<tr>
<td>4</td>
<td>My company objectives are aligned with the group's objective.</td>
<td>5.88%</td>
<td>5.88%</td>
<td>11.76%</td>
<td>35.29%</td>
<td>41.18%</td>
<td>3.99</td>
</tr>
<tr>
<td>5</td>
<td>Team members are committed to accomplish common goals.</td>
<td>0.00%</td>
<td>0.00%</td>
<td>35.71%</td>
<td>57.14%</td>
<td>7.14%</td>
<td>3.71</td>
</tr>
<tr>
<td>6</td>
<td>We work better as a team.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>46.15%</td>
<td>46.15%</td>
<td>4.23</td>
</tr>
<tr>
<td>7</td>
<td>My job benefits the team.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>23.08%</td>
<td>30.77%</td>
<td>38.46%</td>
<td>3.92</td>
</tr>
<tr>
<td>8</td>
<td>Team members help to integrate new members.</td>
<td>0.00%</td>
<td>12.50%</td>
<td>6.25%</td>
<td>62.50%</td>
<td>18.75%</td>
<td>3.87</td>
</tr>
</tbody>
</table>
Additionally, given that IPD culture aims to deliver high value to clients and end users, the author also analyzed when feedback from end users was collected. As seen in Fig. 4.10, end users input was collected mostly during the construction phase of the project, mainly because the project under case study is located in Peru’s capital city and the construction phase demanded high levels of interaction between the community and the project team. However, it is worth noting that almost 17% of participants (5 people) stated that input from clients or end users was not used in the project at all, and only around 33% of participants said that such input was used during the project definition phase. IPD teams, however, should try to involve the client or end users as much as they can from the project definition phase, which suggests that some effort is needed to involve relevant parties from the beginning of the project. By involving clients and end users in the early phases of infrastructure projects, positive impacts are expected in the operation and maintenance phases since mainly potential user problems or complaints should have already been addressed and resolved.

![Figure 4.10 Stage in the Project During Which End Users Input was Used](image-url)
4.8.1.4 Analysis of Safe Environment and Psychological Safety

IPD projects strive to offer safe environments where people feel they can speak up about anything in order to solve problems together and avoid potential conflicts. In Table 4.5, statement 1 has an average rating of 3.73 out of 5, which suggests that the project team still needs to reinforce and encourage the idea of building a collaborative environment. This in turn will create better rapport and improve chemistry among partners. Statements 2, 3 and 4 with an average rating of almost 4.00 out of 5 show that there is a relatively good balance of power among individuals, and they already feel that their voices are being heard to some extent. However, statement 5 drops down to 3.68 points out of 5, which means that even though participants think they are being heard, there remain persistent issues when it comes to communicating with their superiors. Sometimes, one of the biggest obstacles to overcome is a boss or an immediate manager who prevents those being supervised from taking action and making changes because of the leader’s personal fears. Therefore, the creation of a program for IPD leaders play a crucial role in training individuals to lead the changes needed in the industry would be beneficial for the company.

Meanwhile, statement 6 with a rating of 4.31 out of 5 might lead to the assumption that team members do indeed feel free to speak up about anything. Nevertheless, the author asserts that while participants might feel that they can speak up freely, it appears the communication itself is not effective. During site visits, the author observed the continuous issue of people receiving hundreds of emails during the day and struggling to manage such a large amount of information because as engineers they are expected to devote their time to planning and creating strategies, not in dealing with an excessive amount of information that has no adequate channel of communication. Lastly, statement 7 with a rating of 3.50 out of 5 actually supports the author’s belief that in the survivalist culture of traditional construction, important considerations such as safety and quality are being disregarded; therefore, it is necessary to address this issue and foster integrated task planning where everyone on the team is committed to production, quality, and safety with the same level of passion. Such commitment needs to be included in the action plan for improvement.
### Table 4.5 Answers in the Case Study Regarding Psychological Safety

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I can feel chemistry in my project team.</td>
<td>0.00%</td>
<td>6.67%</td>
<td>26.67%</td>
<td>53.33%</td>
<td>13.33%</td>
<td>3.73</td>
</tr>
<tr>
<td>2</td>
<td>Team shows consideration to new members.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>15.38%</td>
<td>46.15%</td>
<td>30.77%</td>
<td>3.92</td>
</tr>
<tr>
<td>3</td>
<td>No one is more important than others.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>7.69%</td>
<td>61.54%</td>
<td>23.08%</td>
<td>3.92</td>
</tr>
<tr>
<td>4</td>
<td>The team wants to hear my voice.</td>
<td>7.69%</td>
<td>7.69%</td>
<td>0.00%</td>
<td>46.15%</td>
<td>38.46%</td>
<td>4.00</td>
</tr>
<tr>
<td>5</td>
<td>I am satisfied with the communication with my supervisor.</td>
<td>6.25%</td>
<td>6.25%</td>
<td>6.25%</td>
<td>75.00%</td>
<td>6.25%</td>
<td>3.68</td>
</tr>
<tr>
<td>6</td>
<td>I can speak up about anything.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>7.69%</td>
<td>23.08%</td>
<td>61.54%</td>
<td>4.31</td>
</tr>
<tr>
<td>7</td>
<td>I see a commitment to safety.</td>
<td>12.50%</td>
<td>0.00%</td>
<td>18.75%</td>
<td>62.50%</td>
<td>6.25%</td>
<td>3.50</td>
</tr>
</tbody>
</table>

#### 4.8.1.5 Knowledge Sharing and Communication Flow in the Case Study

The author aimed to analyze in this section how effectively information was being shared and whether IPD was helping to improve communication in the project. In Table 4.6, statement 1 has a negative connotation, so in this particular case, the closer the rating is to 5, the worse the scenario. The statement affirms that there is a bottleneck in sharing information about the project, which means that information is not flowing as expected;
the rating of 2.68 out of 5 reflects this problem. This rate suggests that some effort is required in the action plan to improve knowledge sharing. Statement 2 reinforces the assumption that people really think that they can achieve better outcomes by sharing ideas; however, it is worth noting that the rating is 4.08 out of 5.00, which means that the organization still needs to convince some people about the importance and benefits of sharing ideas to keep improving the current state of practice. Similarly, statement 3 with a rating of 3.75 out of 5 suggests that the teams are not doing a great job of sharing information among the project participants. Moreover, statement 4 strongly reinforces the fact that information sharing is a persistent issue that gets particularly worst when talking about information sharing across different projects. A recommendation to deal with such issues shall also be included in the action plan. Lastly, statement 5 analyzes the knowledge that participants had regarding how IPD positively impacts communication in the project under study. This statement got an average rating of 3.85 out of 5, and the author assumes that the lack of knowledge regarding IPD benefits might have caused the lower score. This perception will likely change over time once participants get to experience a truly integrated project.

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There is a bottleneck in sharing information.</td>
<td>6.25%</td>
<td>43.75%</td>
<td>25.00%</td>
<td>25.00%</td>
<td>0.00%</td>
<td>2.68</td>
</tr>
<tr>
<td>2</td>
<td>We do things better by sharing ideas.</td>
<td>0.00%</td>
<td>7.69%</td>
<td>15.38%</td>
<td>38.46%</td>
<td>38.46%</td>
<td>4.08</td>
</tr>
<tr>
<td>3</td>
<td>We do a great job in sharing information in the project.</td>
<td>0.00%</td>
<td>18.75%</td>
<td>0.00%</td>
<td>68.75%</td>
<td>12.50%</td>
<td>3.75</td>
</tr>
<tr>
<td>Item</td>
<td>Answer</td>
<td>1 (Never)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5 (Always)</td>
<td>Weighted Mean</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>4</td>
<td>We do a great job in sharing information between projects.</td>
<td>0.00%</td>
<td>31.25%</td>
<td>25.00%</td>
<td>37.50%</td>
<td>6.25%</td>
<td>3.18</td>
</tr>
<tr>
<td>5</td>
<td>IPD helps to improve communication.</td>
<td>7.69%</td>
<td>0.00%</td>
<td>15.38%</td>
<td>58.85%</td>
<td>23.08%</td>
<td>3.85</td>
</tr>
</tbody>
</table>

### 4.8.1.6 Continuous Improvement in the Case Study

Continuous improvement has been a pillar of Lean since the beginning of its development. Because continuous knowledge sharing, and continuous improvement will become more readily adopted in projects through IPD, it is expected that there will still be a variety in the quality of the construction processes. The author asked the participants whether the construction processes the teams were applying in the project had improved with respect to previous projects or had remained largely the same. The results in Fig 4.11 show that around 77% of participants think they have improved their processes, and only 15% of participants thought that their processes were similar to previous projects with no major improvements being done. This is a very positive result not only for the 77% of the participants (representing 20 people) that think they have somehow improved but also for the 8% of participants who think they are using the best practices worldwide because they are pushing their boundaries by using the practices of foreign countries with the expectation of improving the current state of affairs. These are individuals who are not satisfied with making minimal improvements.
The researcher also aimed to briefly analyze the main barriers to innovation since it is a key factor for continuous improvement. As is shown in Fig 4.12, resistance to change is the main barrier against innovation, followed by the belief that innovation might require a high capital investment. Nonetheless, most companies already account for a certain number of training hours for their employees. Consequently, a training program that focuses efforts in the right direction might have a higher impact than expected. Innovation does not necessarily imply the need to acquire new technology but rather focuses on changing the way people think. Therefore, the ways in which they behave can actually cause much more impact than substituting tools or machinery for people.
Some of the statements that were included in the first round of surveys regarding continuous improvement are shown in Table 4.7. Statements 1 and 2 have an average rating of 2.87 out of 5 points, which means that the project teams still have not included innovation-focused meetings as a best practice, and the participants do not see the value in such meetings when they do occur. Therefore, a lot of effort is required to build a routine of meetings where major parties are expected to participate and decisions can be made based on what is best for the project. The training program previously suggested shall also help improve the rating of statement 2 since once the participants acknowledge the capabilities of IPD, they will feel more motivated to attend such meetings and will together increase the value delivered in the meetings.

Finally, team commitment to continuous improvement also got a low rating of 3.76 out of 5 points. Therefore, it is also expected that learning more about IPD will increase participant commitment, it is recommended that support be sought from an IPD leader and that participants be empowered in order to create a sense of ownership of the project among them.
Table 4.7 Answers in the Case Study Regarding Integrated Culture

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>We organize innovation meetings as a best practice.</td>
<td>12.50%</td>
<td>31.25%</td>
<td>18.75%</td>
<td>31.25%</td>
<td>6.25%</td>
<td>2.87</td>
</tr>
<tr>
<td>2</td>
<td>I see value in the weekly innovation meetings.</td>
<td>18.75%</td>
<td>31.25%</td>
<td>6.25%</td>
<td>31.25%</td>
<td>12.50%</td>
<td>2.87</td>
</tr>
<tr>
<td>3</td>
<td>Our team is committed to continuous improvement.</td>
<td>5.88%</td>
<td>5.88%</td>
<td>11.76%</td>
<td>58.82%</td>
<td>17.65%</td>
<td>3.76</td>
</tr>
</tbody>
</table>

4.8.1.7 Early Involvement of Stakeholders in the Case Study

The author aimed to assess the participants’ perceptions regarding the early involvement of stakeholders since gathering opinions from main players downstream in the early phases of the project is a key factor in developing integrated projects. Therefore, a question was included about whether they believe that early stakeholder involvement adds value to the project. An overwhelming 93.3% of participants agreed with the statement that says early involvement of parties adds value to the project (see Fig. 4.13) while a minority of participants were not sure. It is worth noting that no one thought early stakeholder involvement did not add any value.
In traditional projects, there is not much interaction from downstream players at the beginning of the project, and usually most of them are brought into the project just after construction starts (see Fig. 4.14). Major players in the project under study were identified, and a scheme of the time they should be involved in the project has been included in Figure 4.15. As can be seen in the figure, the operation and maintenance party was included in project conversations beginning with the conceptualization of the project during the definition phase. Based on site visits, the author observed that more emphasis was placed on bringing the facility manager into talks early on to get feedback about the project and adjust the design accordingly. Even though there was no previous routine for such interactions, the dynamic of bringing people who will operate the facility in for conversations has already begun and looks like it will continue.

Figure 4.13 Percentage of Participants Who Believe Early Stakeholder Involvement Adds Value to the Project

Figure 4.14 Involvement of Stakeholders in Traditional Delivery Methods (after Litchig, 2006; AIA, 2007)
4.8.1.8 Co-location of Stakeholders in the Project

Project A involved major stakeholders early in the project’s phases as shown in Fig. 4.16. Specifically, it is worth noting the involvement of the engineering and construction companies engaged for later phases and the participation of the operations and maintenance company since they played a major role in defining the scope and details of the project. Co-location of team members allow for an honest, valid, and valuable exchange of ideas (Chen and Manley, 2014).

Even though it is clear from the previous section that parties were involved early in the project’s life cycle, it is also important to note which phases of the project those parties were most involved in. Fig. 4.16 describes which project phases the participants were co-located in and worked collaboratively through. This figure also supports previous findings that reaffirmed how every party was involved from the design phase of the project; some parties have more involvement than others, but all of them were involved to some extent.
Next, Fig. 4.17 shows the different phases of the project under study and the participants’ involvement in each phase. It can be seen that more effort was devoted to the initial phases of the project than to latter phases. However, the graph also suggests that great effort was put forth when construction began. The author asserts that this scenario persisted mainly because the team is still transitioning from the traditional project delivery approach in which the greatest amount of effort is devoted to the late stages of a project.
When project parties are co-located in a common area, it is important that they add value to any meetings and that they realize such meetings are in turn adding value to their own work; otherwise, their participation will have no effect at all, and the exercise of co-locating team members will not be successful. As seen in Table 4.8, two important factors of co-location were analyzed. First, participant perceptions of the weekly meetings and the impact of those meetings on the project were explored. Even though most participants found that such meetings added value to the project, there were a few people who do think that weekly meetings are not worthwhile. This type of thinking is disadvantageous for the team because integrated teams require the commitment of all team members and people will not commit to something that they think is not adding value to the project. It is evident in statement 1, which has a rating of 3.82 out of 5, that the way meetings are been conducted requires improvement. Making adjustments to the agenda or the way meetings are run is needed to develop effective talks and engage all participants in them. Second, it is critical for co-located participants to listen to one another’s ideas. The point of bringing different players to the table is to find better ways of doing something; therefore, listening is a
characteristic that needs further development. As seen in the second statement with a mean rating of 3.88 out of 5, team members are only sometimes listening to one another’s ideas. The author assumes that by improving the first statement’s rating, the second statement’s rating will also increase.

Table 4.8 Answers in the Case Study Regarding Co-location of Team Members

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The weekly meetings add value to the project.</td>
<td>5.88%</td>
<td>5.88%</td>
<td>17.65%</td>
<td>41.18%</td>
<td>29.41%</td>
<td>3.82</td>
</tr>
<tr>
<td>2</td>
<td>Team members listen to each other.</td>
<td>0.00%</td>
<td>11.76%</td>
<td>5.88%</td>
<td>64.71%</td>
<td>17.65%</td>
<td>3.88</td>
</tr>
</tbody>
</table>

Given that developing highly effective meetings is fundamental when co-locating the project teams, the author asked the participants during site visits how they would improve the team meetings and responses were formally documented and validated in the survey conducted by LCI Peru. The responses varied from “attending meetings with a mindset of looking for solutions instead of imposing ideas on others,” to “attending on time and having all the decision makers coming to the meeting,” “involving people actively and keeping a weekly routine,” “having short meetings previous to the general one and making sure commitments are completed in advanced,” “establishing commitments with the project team,” and “improving accomplishment of activities committed in the previous week and removal of constraints.” The common theme among the concerns that participants shared was the issue of bringing people together, keeping track of their task compliance, and the overall sequence of events in such meetings. Improving how meetings are held might also help transform the work culture to one of increased trust, collaboration, and shared learning. Moreover, onboarding processes are needed when people are being encouraged to get involved in the early stages of the project (Seed, 2015) so that they can better comprehend
the work process and its effectiveness while getting used to using the tools previously mentioned.

4.8.1.9 Sharing Risks and Rewards

The general idea of creating a win-win or lose-lose scenario is still developing in Peru, and most players might not be aware of the policies or approaches to support such a shared ideal. The two statements presented in Table 4.9 both got low rates, confirming the author’s assumptions on this topic. The first statement proves that companies involved with the project are failing to create approaches for sharing risks and rewards. With more than 30% of participants saying that they never or almost never shared risks and rewards, the author found a potential area for improvement that shall be included in the plan of action proposed in this study. The second statement also proves that even though people started working together and were co-located in the project, there is still a need to improve such collaborative work. Knowing other parties’ success metrics is a basic requirement for accomplishing the goal of integration. By understanding what success means for other parties, team members can easily align their interests and define objectives for the betterment of the team.

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>We share risks and rewards</td>
<td>15.38%</td>
<td>15.38%</td>
<td>38.46%</td>
<td>30.77%</td>
<td>0.00%</td>
<td>2.85</td>
</tr>
<tr>
<td>2</td>
<td>I know other companies’ success metrics</td>
<td>7.69%</td>
<td>15.38%</td>
<td>30.77%</td>
<td>30.77%</td>
<td>15.38%</td>
<td>3.31</td>
</tr>
</tbody>
</table>

One common approach for sharing wins and losses in a project is to add some incentivizing mechanisms into the contract. It is a fact that IPD contracts are a completely new topic in Peru, but there are some clauses that can be included in traditional contracts that might support the relational role of integrated contracts. For the case study analyzed, as it is seen
in Figure 4.18, only a few parties (16%) used incentives based on project performance in their contracts, whereas the other 84% did not have such mechanisms. To bring all parties onboard, it is necessary to make them feel empowered and responsible for what they are doing. Adding sharing mechanisms will positively impact this endeavor.

![Figure 4.18 Participants Who Had Included Incentives for Performance in Their Contracts](image)

**4.8.1.10 Collaborative Decision-Making**

Co-locating parties positively impacts the decision-making process. Previous results in this study showed that there was more involvement in the project from various parties in earlier project phases than later ones. Because an objective in integrated projects is to gain party consensus when making decisions for the betterment of a project, the author analyzed which parties had been involved in the decision-making process in this particular case. The author aimed to illustrate the detailed decision-making process in regard to parties involved for certain decisions. According to the team members who participated in the study, project stakeholders agreed on decisions related to the project by consensus in the following proportions (see Fig 4.19).
The involvement of different parties in making decisions was further explored in the study. Team members’ level of involvement varied in decisions concerning project scope, cost, schedule, change orders, and interferences. Therefore, when compared to traditional approaches, there seems to be an improvement in bringing stakeholders in earlier and involving them in the decision-making process to improve project delivery. The author shows in Fig. 4.20 which kinds of decisions the different parties in the project were involved with.
Table 4.10 introduces participants’ perceptions about their roles in the decision-making process and the role of the superintendent. As statement 1 shows, participants have a positive perception about their roles in making decisions because they feel they are part of the process. Ownership and a sense of belonging help bring about a collaborative mindset. Similarly, in the second statement, there is a recognition that superintendents play a key role in such a process. However, the average rating is still low, and more emphasis shall be focused on improving this opinion because the superintendents are the ones closely managing people in operations or out in the field. Since they have direct interaction with the people who will actually build the project, their voices and experiences are important and shall be regarded as such.

<table>
<thead>
<tr>
<th>Item</th>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am part of the decision-making process.</td>
<td>7.69%</td>
<td>7.69%</td>
<td>0.00%</td>
<td>38.46%</td>
<td>46.15%</td>
<td>4.08</td>
</tr>
<tr>
<td>2</td>
<td>Superintendents are key in the decision-making process.</td>
<td>7.69%</td>
<td>15.38%</td>
<td>30.77%</td>
<td>38.46%</td>
<td>7.69%</td>
<td>3.23</td>
</tr>
</tbody>
</table>

### 4.8.2 IPD Tools Applied in the Case Study

Generally, there is a lack of knowledge in Peru concerning IPD and the different tools available for use in a given project. Previous studies have suggested that practices and tools such as co-location, onboarding, A3, and CBA can potentially support the successful implementation of IPD in projects (Cheng, 2016). Results in the case (Fig. 4.21) study show that most of the participants (87%) are aware of the Last Planner System (LPS), so there seems to be considerable opportunity to start using the big room effectively. Meanwhile, there is also a need to establish an onboarding process for the whole team when
new members are being brought in. Therefore, the company’s initial efforts to foster co-location, as seen in section 4.5.1.8, might need some adjustments to make the practice more effective.

![Figure 4.21 Tools Being Used by Case Study Participants](image)

The author also dug into the factors that have contributed to project performance for the case study and found that among the highest-contributing factors to project success are co-locating and onboarding, as seen in Fig. 4.22. Participants rated each option from 1 to 10 based on the importance of each factor in the project’s success and had the ability to add other factors that they considered important for the project. Surprisingly, the results from this section were that “team” and “strategy” got the lowest rates. These results are not aligned with an integrated project, which values team dynamics and the strategizing that occurs to develop a project. A change in mindset with respect to these factors that affect the success of a project will come over time as people are better trained in IPD.
4.8.2.1 Last Planner System (LPS) in the Case Study

One of the most important tools presented in the conceptual framework for implementing IPD is the Last Planner System (LPS). Planning is key for any project, and according to the literature review LPS is critical for successful IPD implementation. However, most projects in Peru are only still using software such as MS Project or Primavera P6 to manage their project planning and control. In Figure 4.23, the author included a piece of the master planning of Project A in MS Project.
In the project under study, LPS sessions were developed (see Fig. 4.24) with the collaboration of the different project stakeholders involved in the different phases of the project. A leading team of LPS implementation guided the sessions at the beginning and help the team acquire some practice by themselves.
4.8.2.2 Target Value Design (TVD)

The author analyzed the impact of applying IPD principles such as Target Value Design (TVD), pull scheduling, and ownership of tasks and report the findings in detail in this study. It was observed during site visits that the willingness to collaborate improved during the design phase, and the team members worked on growing their leadership capabilities using a formal and structured scheme. The project team members jointly defined the scope of the work and developed a target cost below the market cost, which resulted in the company being awarded the project. However, due to the lack of knowledge regarding practices such TVD in Peru, Project A target value was not developed properly. A scheme of costs in Project A is shown in Figure 4.25. From that picture, it can be seen that the team had a higher amount of money under risk than what they can achieve as profit. Also, based on discussions with the project team, the author concluded that there was not pain/gain sharing mechanisms properly established in the project, which might have caused misalignment among main players.

![Target Cost Scheme in Project A](image)

4.8.2.3 Choosing by Advantages (CBA) in the Case Study

The success of the project requires the use of tools that facilitate taking decisions for the best of project such CBA. It was found in the case study that the is lack of knowledge in
regards of CBA as Table 4.11 shows. Lately however, LCI Peru started organizing workshops where people can learn about CBA (see Fig. 4.26).

<table>
<thead>
<tr>
<th>Statements Regarding the Use of CBA in the Project</th>
<th>Participants Supporting Each Statement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know and have used CBA to choose the best options for the project.</td>
<td>7.14%</td>
</tr>
</tbody>
</table>

Figure 4.26 Add Used by LCI Peru for Announcing CBA Workshop

4.8.2.4 A3 Reports in the Case Study

The author included in the case study questions regarding the use of A3s. I can be seen in Table 4.12 that only half of the participants understand and use A3 formats for problem-solving. Also, it is shown that there is initiative of the participants to look for help from the community to better solve problems. The author also found that participants do not completely feel that they belong to a community of thinkers nor that the team collaborates to solve problems. Therefore, the plan of action shall consider improving such areas and help participants collaborating together to solve problems.
Table 4.12 Use of A3s for Problem-Solving in Peru

<table>
<thead>
<tr>
<th>Statements Regarding Problem-Solving and Use of A3</th>
<th>Participants Supporting Each Statement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am part of a community of thinkers.</td>
<td>42.86%</td>
</tr>
<tr>
<td>Team members collaborate to solve problems.</td>
<td>41.86%</td>
</tr>
<tr>
<td>I look for support from the community to solve problems.</td>
<td>71.43%</td>
</tr>
<tr>
<td>I clearly understand and use the A3 tool for problem-solving.</td>
<td>50.00%</td>
</tr>
</tbody>
</table>

4.8.3 Project Governance Structure in IPD Case Study in Peru

It is important to create a collaborative environment where open communication can flourish (Matthews and Howell, 2005). In practice, there are different parties involved in an infrastructure project and each has a unique point of view, so putting their ideas together can lead to project optimization (Mossman et al., 2010). Team alignment is understood as “the process of incorporating all the distinct priorities and requirements of project participants to create a uniform set of project objectives that meet the business needs of the facility” (Griffith, 1998 pg. 38). For this case study, different parties were involved in the early stages of the project. The team developed a scheme to show the stages where each party would be getting involved in the project. The partners that were involved in the design phase are the client from the infrastructure division, the general contractor, the designers, and the operation and maintenance contractor. Some of the other subcontractors were also involved during the early planning phases before construction started.

4.9 Conceptual Framework Feasibility Based on Peruvian Construction Industry (Phase 3)

The first part of the research analyzed a sample case study of a company that was trying to apply IPD in one of its projects. Second, the author aimed to expand the analysis for the Peruvian construction industry by analyzing results of a survey conducted by LCI Peru. The study focused on current construction practices in Peru, and therefore, not all the tools and principles in the conceptual framework will be analyzed because Peruvian construction
industry is not well developed in terms of IPD, only those principles and tools most relevant in the Peruvian sector are analyzed.
Additionally, the author used the five paths of knowledge proposed by LCI. The framework is divided into such five different paths and includes a suggested integrated governance structure.

4.9.1 Current State of Main Principles Governing IPD in Peru

Projects using IPD employ multiple principles (Fig. 4.27) to facilitate its implementation even when the level of awareness about these tools being a part of IPD is very low. The results shown in Figure 4.27 support the author’s observations during site visits to the company. The author selected key principles and tools to measure the current state of principles that are influencing IPD application in Peru.

![Figure 4.27 Current State of Main IPD Principles Being Applied in Peru](image-url)
4.9.1.1 Wisdom Path in IPD

The wisdom path aims to define where the level of knowledge and awareness of the participants is in regard to the founding principles of Lean. The ideal status in this path looks for people to have a strong knowledge of Lean principles and are strongly self-motivated to keep learning by regularly making efforts to perform learning activities. In the Peruvian construction industry, results in Table 4.13 show that participants are struggling on making time to keep learning about Lean and lack of knowledge regarding available resources.

Table 4.13 Knowledge Regarding Wisdom of Lean Principles

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I take time to learn Lean principles, I gather information from different sources (e.g., leaders, seminars, books, and papers).</td>
<td>11%</td>
<td>44%</td>
<td>13%</td>
<td>26%</td>
<td>5%</td>
<td>2.69</td>
</tr>
<tr>
<td>I make time to keep up with Lean principles by regularly learning (e.g., from lectures, seminars, papers, and books).</td>
<td>16%</td>
<td>48%</td>
<td>16%</td>
<td>13%</td>
<td>6%</td>
<td>2.45</td>
</tr>
<tr>
<td>Even if I don’t have time, I make an effort to learn Lean principles.</td>
<td>24%</td>
<td>49%</td>
<td>14%</td>
<td>10%</td>
<td>3%</td>
<td>2.20</td>
</tr>
<tr>
<td>When I can’t understand aspects of the Lean principles, I reach out to our Lean champion for help.</td>
<td>20%</td>
<td>48%</td>
<td>11%</td>
<td>16%</td>
<td>5%</td>
<td>2.39</td>
</tr>
<tr>
<td>Answer</td>
<td>1 (Never)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5 (Always)</td>
<td>Weighted Mean</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>When learning about Lean principles, I try to implement them as often as I can (i.e., learning while doing).</td>
<td>13%</td>
<td>37%</td>
<td>23%</td>
<td>16%</td>
<td>11%</td>
<td>2.76</td>
</tr>
<tr>
<td>I think I will be able to use what I learn from this project on other projects.</td>
<td>2%</td>
<td>11%</td>
<td>14%</td>
<td>23%</td>
<td>52%</td>
<td>4.12</td>
</tr>
<tr>
<td>One of the most satisfying things for me is to develop a deep understanding of Lean principles.</td>
<td>4%</td>
<td>24%</td>
<td>13%</td>
<td>20%</td>
<td>38%</td>
<td>3.62</td>
</tr>
<tr>
<td>Developing a strong knowledge of Lean principles is really valuable to me.</td>
<td>4%</td>
<td>24%</td>
<td>24%</td>
<td>20%</td>
<td>28%</td>
<td>3.43</td>
</tr>
<tr>
<td>Even though Lean principles are new to me, I believe I'm doing well in my learning path.</td>
<td>4%</td>
<td>37%</td>
<td>39%</td>
<td>13%</td>
<td>7%</td>
<td>2.80</td>
</tr>
</tbody>
</table>

Key takeaways in this section showed that most participants are aware that Lean principles are new to them; however, they are not making much effort on keep learning regularly (see Fig. 4.28). It is important to incentivize participants to build a learning culture where they go to different sources whenever they lack knowledge regarding a topic.


4.9.1.2 Mindfulness Path in IPD

Mindfulness path aims to identify the state of people evaluating and monitoring their own work to foster continuous improvement and learning. Questions in this path helps identifying the level of knowledge and awareness in regards of practices of retrospection. The goal is to have and foster innovative ways to frequently evaluate participants own work since people learn and improve performance from experiments and breakdowns. In the study, Table 4.14 shows results to questions regarding mindfulness path and Figure 4.29 shows that participants lack knowledge about retrospective activities neither they find the time to perform activities they know.
<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I rarely find time to perform retrospective activities.</td>
<td>14%</td>
<td>52%</td>
<td>20%</td>
<td>11%</td>
<td>3%</td>
<td>2.37</td>
</tr>
<tr>
<td>I have strong knowledge of what retrospective activities are.</td>
<td>6%</td>
<td>43%</td>
<td>39%</td>
<td>13%</td>
<td>0%</td>
<td>2.59</td>
</tr>
<tr>
<td>I could make a stronger effort to perform retrospective activities.</td>
<td>1%</td>
<td>26%</td>
<td>30%</td>
<td>25%</td>
<td>17%</td>
<td>3.30</td>
</tr>
<tr>
<td>I try to implement retrospection as often as I can.</td>
<td>10%</td>
<td>33%</td>
<td>38%</td>
<td>10%</td>
<td>9%</td>
<td>2.74</td>
</tr>
<tr>
<td>I make sure I keep up with my performance by regularly checking my work.</td>
<td>1%</td>
<td>17%</td>
<td>31%</td>
<td>30%</td>
<td>20%</td>
<td>3.50</td>
</tr>
<tr>
<td>I believe I’m doing well in performing retrospective activities.</td>
<td>3%</td>
<td>23%</td>
<td>46%</td>
<td>18%</td>
<td>10%</td>
<td>3.10</td>
</tr>
<tr>
<td>I believe that performing retrospective activities brings great value.</td>
<td>1%</td>
<td>11%</td>
<td>26%</td>
<td>37%</td>
<td>25%</td>
<td>3.73</td>
</tr>
<tr>
<td>I try to apply retrospective activities in various aspects of the project (i.e., learning with doing).</td>
<td>4%</td>
<td>18%</td>
<td>39%</td>
<td>28%</td>
<td>11%</td>
<td>3.24</td>
</tr>
</tbody>
</table>
4.9.1.3 Leadership Path in IPD

Leadership path analyzes the ability of people to teach and lead other members of the team. Leaders with a high foundation of Lean are motivated to help their team grow. Results of the study in Table 4.15 show that motivation for leaders to share knowledge is low potentially due their lack of experience.

Table 4.15 Knowledge Regarding Leadership in Projects

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I help my team members in implementing Lean principles as often as I can.</td>
<td>19%</td>
<td>32%</td>
<td>11%</td>
<td>13%</td>
<td>9%</td>
<td>2.56</td>
</tr>
<tr>
<td>Answer</td>
<td>1 (Never)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5 (Always)</td>
<td>Weighted Mean</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>When my team is confronted with a breakdown, I work hard with them in resolving the conflict.</td>
<td>2%</td>
<td>6%</td>
<td>25%</td>
<td>34%</td>
<td>34%</td>
<td>3.92</td>
</tr>
<tr>
<td>When I can’t deliver, I seek help from my team.</td>
<td>2%</td>
<td>23%</td>
<td>28%</td>
<td>26%</td>
<td>21%</td>
<td>3.42</td>
</tr>
<tr>
<td>I don't really pay attention to the team members that need help.</td>
<td>58%</td>
<td>30%</td>
<td>2%</td>
<td>10%</td>
<td>0%</td>
<td>1.64</td>
</tr>
</tbody>
</table>

The graphical representation of outcomes in this section is shown in Figure 4.30 and highlighted are the areas where improvement is more needed such as motivating and helping people in their teams to implement Lean principles.

![Figure 4.30 Leadership Path Current State Representation in Peru](image-url)
Another question included in the study aims to know the willingness of leaders to share their knowledge about specific tools. The question added was “I want all of my team members to be able to:” Table 4.16 shows detailed answers of the study.

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master the Lean principles.</td>
<td>6%</td>
<td>9%</td>
<td>19%</td>
<td>15%</td>
<td>51%</td>
<td>3.96</td>
</tr>
<tr>
<td>Become leaders.</td>
<td>4%</td>
<td>6%</td>
<td>19%</td>
<td>12%</td>
<td>60%</td>
<td>4.17</td>
</tr>
<tr>
<td>Foster a safe environment for discussions.</td>
<td>4%</td>
<td>4%</td>
<td>21%</td>
<td>23%</td>
<td>48%</td>
<td>4.08</td>
</tr>
<tr>
<td>Make reliable commitments.</td>
<td>2%</td>
<td>4%</td>
<td>18%</td>
<td>24%</td>
<td>53%</td>
<td>4.22</td>
</tr>
<tr>
<td>Develop a collaborative environment based on respect.</td>
<td>4%</td>
<td>4%</td>
<td>17%</td>
<td>12%</td>
<td>63%</td>
<td>4.27</td>
</tr>
<tr>
<td>Perform retrospective activities.</td>
<td>4%</td>
<td>4%</td>
<td>17%</td>
<td>25%</td>
<td>50%</td>
<td>4.13</td>
</tr>
<tr>
<td>Apply the Last Planner System.</td>
<td>4%</td>
<td>6%</td>
<td>23%</td>
<td>15%</td>
<td>51%</td>
<td>4.02</td>
</tr>
</tbody>
</table>

A more visual representation is presented in Figure 4.31 where it can be seen color-coded which practices have not been applied at all or have somehow been applied but not fully as expected.
4.9.1.4 Integration Path in IPD

The integration path accounts for solving the issue of fragmentation. As Sumner and Slattery (2010) found in their research, it is more important to assemble project teams “composed of people who have demonstrated the ability to work well with others” than “a group of individuals who all have strong leadership skills”. Table 4.17 shows detailed results of the study and the author concluded that: Participants are not taking much time to learn from each other and build relations and team members are somehow aware that they are part of a team and that their behavior influences the whole group.

Table 4.17 Knowledge Regarding Integration in Projects

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>We take time to learn about each other (e.g., where we are from, hobbies, etc.).</td>
<td>4%</td>
<td>39%</td>
<td>29%</td>
<td>19%</td>
<td>9%</td>
<td>2.88</td>
</tr>
<tr>
<td>Answer</td>
<td>1 (Never)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5 (Always)</td>
<td>Weighted Mean</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-----------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>------------</td>
<td>--------------</td>
</tr>
<tr>
<td>I'm aware that my behavior influences the group.</td>
<td>1%</td>
<td>21%</td>
<td>25%</td>
<td>36%</td>
<td>17%</td>
<td>3.46</td>
</tr>
<tr>
<td>I feel that I am part of the team rather than just a hired specialist.</td>
<td>3%</td>
<td>12%</td>
<td>22%</td>
<td>28%</td>
<td>35%</td>
<td>3.81</td>
</tr>
<tr>
<td>I think my team values the common goals of the project over their own organizations’ goals.</td>
<td>2%</td>
<td>21%</td>
<td>33%</td>
<td>33%</td>
<td>12%</td>
<td>3.31</td>
</tr>
<tr>
<td>We are willing to sacrifice the team's goals for our own personal goals.</td>
<td>53%</td>
<td>25%</td>
<td>7%</td>
<td>7%</td>
<td>8%</td>
<td>1.93</td>
</tr>
<tr>
<td>We tend to be defensive or guarded when discussing the project's issues.</td>
<td>27%</td>
<td>41%</td>
<td>21%</td>
<td>10%</td>
<td>1%</td>
<td>2.18</td>
</tr>
</tbody>
</table>

Figure 4.32 shows key points for improvement highlighted in the integration path. For example, as it is seen in the figure, companies should create an environment where people can interact and learn from each other. Most participants of the research are aware of how their behavior influences the whole team.
4.9.2 Current State of Main Tools Facilitating IPD in Peru (Strategy Path)

At the level of tools being applied in Peru, the respondents mostly agree that they have heard about most of the tools, but they do not use them very often nor have they mastered such tools well enough to teach them to the other team members (see Fig. 4.33). As was pointed in chapter 3, setting and steering to targets in construction is fundamental to build the much-needed trust still missing in the Peruvian construction industry. Figure 4.33 shows how almost 60% of participants have only heard about such tools, and less than 10% use them as best practices in their projects. Moreover, the even bigger issue is that none of them consider themselves experts who can teach others about a given tool. Therefore, giving appropriate trainings on set-based design and target value design (TVD) is critical for the successful implementation of IPD in Peru.
4.9.2.1 Last Planner System (LPS) in Infrastructure Projects in Peru

Based on the questions regarding LPS in phase 3, the author found that the majority of stakeholders’ lack of knowledge in regard of LPS in its different levels of application. The statement in Table 4.18 got a rating of 1.71 out of 5 points meaning that LPS application if very low in the market. Most participants (62% = 46 people) have only heard about it, but they do not apply it in their projects. Also, only 3% of participants believe they master the tool and can teach it. Therefore, training is required to mitigate such issue.

Table 4.18 LPS Usage

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (I have heard about it)</th>
<th>2 (I have used it)</th>
<th>3 (I use it often)</th>
<th>4 (I recognize best practices)</th>
<th>5 (I can teach it)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage of LPS in the project</td>
<td>62%</td>
<td>21%</td>
<td>6%</td>
<td>9%</td>
<td>3%</td>
<td>1.71</td>
</tr>
</tbody>
</table>

Table 4.19 included a question that says, “I think I have strong knowledge about the following techniques:”. As results show, all practices got low rating from participants.
Table 4.19 Knowledge Regarding LPS Techniques

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (Never)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (Always)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase “Pull” Planning</td>
<td>24%</td>
<td>45%</td>
<td>12%</td>
<td>14%</td>
<td>5%</td>
<td>2.31</td>
</tr>
<tr>
<td>Look Ahead Planning</td>
<td>14%</td>
<td>33%</td>
<td>24%</td>
<td>18%</td>
<td>10%</td>
<td>2.78</td>
</tr>
<tr>
<td>Make-Ready Planning</td>
<td>8%</td>
<td>40%</td>
<td>23%</td>
<td>17%</td>
<td>13%</td>
<td>2.85</td>
</tr>
<tr>
<td>Weekly Work Planning</td>
<td>12%</td>
<td>31%</td>
<td>27%</td>
<td>16%</td>
<td>14%</td>
<td>2.88</td>
</tr>
<tr>
<td>Daily Huddles</td>
<td>6%</td>
<td>36%</td>
<td>26%</td>
<td>10%</td>
<td>22%</td>
<td>3.06</td>
</tr>
</tbody>
</table>

In Figure 4.34, the previous table is expressed graphically to help readers visualize what levels of LPS practitioners master and what are not used often in the industry. As it is shown, daily huddles are the most commonly practice in Peru with more than 20% of participants are knowledgeable about the tool. However, in the same graph, it can be visualized that LPS is not being used much for phase planning with almost 25% of participants stating that they never practice or use LPS for phase planning.

Figure 4.34 Wisdom Path Current State Representation in Peru
4.9.2.2 Target Value Design (TVD) in Infrastructure Projects in Peru

The involvement of Peruvian practitioners with tools such TVD is very low and it was confirmed by the results in the study where the participants acknowledge they had barely heard the term TVD and none of them can actually master the topic and can teach it (see Table 4.20).

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (I have heard about it)</th>
<th>2 (I have used it)</th>
<th>3 (I use it often)</th>
<th>4 (I recognize best practices)</th>
<th>5 (I can teach it)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage of TVD in the project</td>
<td>61%</td>
<td>26%</td>
<td>11%</td>
<td>3%</td>
<td>0%</td>
<td>1.55</td>
</tr>
</tbody>
</table>

4.9.2.3 Use of A3s in Infrastructure Projects in Peru

The last basic tool analyzed in the study is the use of A3s for problem-solving. As it can be seen in Table 4.21, the mean for A3 usage is still low, almost as low as the usage mean of TVD.

<table>
<thead>
<tr>
<th>Answer</th>
<th>1 (I have heard about it)</th>
<th>2 (I have used it)</th>
<th>3 (I use it often)</th>
<th>4 (I recognize best practices)</th>
<th>5 (I can teach it)</th>
<th>Weighted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage of A3s in the project</td>
<td>59%</td>
<td>26%</td>
<td>3%</td>
<td>12%</td>
<td>0%</td>
<td>1.68</td>
</tr>
</tbody>
</table>

4.9.3 Adjusting Framework Based on Issues to Overcome in Peruvian Construction

To facilitate IPD it is key to overcome the most persistent barriers that might prevent its implementation. Ghassemi and Becerik-Gerber (2011) performed a study to identify potential barriers to implement IPD and categorized them in legal, cultural, financial, and
technological. For the purpose of this study, financial and technological barriers are not addressed because those categories are not included in the scope of the research.

**4.9.3.1 Cultural Issues in the Peruvian Architecture, Engineering, and Construction Industry**

According to Edgar Schein (2009, pg13-14), culture is “a powerful, latent, and often unconscious set of forces, that determine both our individual and collective behavior, ways of perceiving, thought patterns, and values”. In countries, such as Colombia, with similar cultures to Peru, researchers (Forero et al., 2015) have studied the main barriers to IPD implementation and asserted that the lack of trust between the parties involved is the main barrier to implementation. They have also strongly suggested that lack of training is an additional barrier that needs to be overcome. Mollaoglu et al. (2015) mentioned that cultural barriers make people be resistant to change and rather behave as usual.

Bennett et al. (1996) suggest that a way to overcome cultural barriers and develop a collaborative culture is by actively pursuing change using various techniques and tools. As Howell and Ballard (1997) said, “it is relatively easy to contract for the purchase of a thing and relatively difficult to contract for behavior”. Internal resistance is identified as a common obstacle for IPD implementation (Kim et al., 2016). Ghassemi and Becerik-Gerber (2011) said that cultural barriers are translated into the unwillingness of the industry to change its traditional methods.

One of the main barriers for integration is the lack of trust among contracting parties (Pishdad-Bozorgi, 2017). Wong et al. (2005) see contractor as trust initiator. Whenever companies work with new partners and want to establish trust among the team, facilitation workshops and training team members in certain practices allow them to acquire trust faster over time. Ghassemi and Becerik-Gerber (2011) suggested that such trust can be achieved through communication as people interact more with each other and training is an effective way to overcome cultural barriers.

Sumner and Slattery (2010) indicated that “team members’ satisfaction with team processes such as communications, trust, problem-solving skills, and common goals” is positively related to team effectiveness and suggested that the whole might be greater than the sum of the parts.
The main challenge when moving towards integration are the different backgrounds, mind-sets, and different sets of values (Denning et al. 2011), so commitment to change and achieve project goals is key when developing integrated projects. Ballard et al. (2007) developed an extensive study to analyze success factors for Lean implementation, and they found that commitment was the most important factor, followed by culture and behavioral changes.

### 4.9.3.2 Legal Issues

Even though Chen and Manley (2014) said that contractual conditions in IPD agreements do not directly impact project performance, it is worth noticing though the main differences between traditional transactional agreements and the integrated agreements for IPD. Traditional contracting is adversarial in nature (Liu, 2013) whereas relational contracting is represented by commitment, trust, cooperation, communication and alignment of goals and objectives (Yeung et al., 2012). As part of the research, the author identified the major reasons that participants in the study suggested for not signing IPD agreements. As it can be seen in Figure 4.35, major reasons included the lack of knowledge regarding such collaborative agreements and the lack of trust within parties (around 20 people supporting each).

![Figure 4.35 Main Barriers to Signing IPD Agreements](image_url)

- Lack of knowledge regarding this type of agreement: 76.92%
- Lack of trust within parties: 76.92%
- Lack of knowledge regarding current legislation: 30.77%
- Lack of commitment and transparency: 23.08%
- Deficiency on the supply chain: 7.69%
Matthews and Howell (2005) have highlighted these common issues with traditional contracting approaches: i) the lack of field input does not allow good ideas to be shared early in the project, ii) cooperation and integration are discouraged, iii) subcontractors are not responsible for each other’s work, which does not encourage collaboration, and iv) there is a focus on maximizing individual profit. On the other hand, relational contracting enables mutual respect and mutual benefit, and it is becoming more common for companies to use this type of agreement. Kim et al. (2016) identified current legislation conflicting with multiparty agreement as one of the main obstacles of implementing IPD. However, when dealing with infrastructure projects in Peru, IPD contracts with public agencies are not allowed due to legal restrictions. But Darrington (2011) has suggested two ways to overcome the legal issues in this scenario:

- Structure the DB contract as a relational contract by adding some clauses or addendums that support IPD philosophy. Such addendum shall be designed to include certain characteristics of integrated projects and specify details that aim to be follow by the project team (Kim et al., 2016). Users who have no experience with IPD relational contracts can use ConsensusDoc300 as a reference. Forero et al. (2015) point out that the industry is suffering from the lack of awareness about the legal parameters amenable for IPD; therefore, organizations aiming to adopt relational agreements might reference some parameters from the United States. Franz and Leicht (2012) developed a process for creating collaboration addendum that captures IPD principles and fosters collaborative team behavior. Pishdad-Bozorgi (2017) documented a case study in which the team included incentives such early completion of the job, staying within budget and saving the team contingency, and innovation.

- Use the DB transactional contract and apply IPD principles and tools that belong to the organization’s culture within the teams and throughout the supply chain without the owner necessarily mandating such action. For example, Ghassemi and Becerik-Gerber (2011) documented a set of cases in which projects used a traditional contract, but they still reinforced important features of IPD such early involvement and collaborative decision-making and they were able to assemble a team that achieve true integration.
- Convince policy makers (politicians, lobbyists, legislators and civil servants) who regulate public legislation accordingly fostering for integration in the construction industry looking for the highest value and no the lowest price.

4.9.3.3 Willingness to Change for Integration

The entire construction industry is moving towards integration, Elvin (2007) developed a research in which findings indicated that around 83% of owners are looking for changing the current project delivery method. The vision for changing to a more collaborative model was strengthened by the company’s willingness to deliver the highest engineering value to its clients and increase the level of service for its infrastructure proposals. The business developer company from the project team under study is leading the initiative as an internal client for the other companies representing design, construction, and operations. The author aimed to understand team member expectations for change and the areas of improvement that they had identified.

Only 16% of participants in the case study in phase 2 perceived the project as being very successful (see Fig. 4.36). Therefore, because participants are not fully satisfied with the success of their projects, it is expected that they would be willing to adopt certain changes and increase their satisfaction level.

![Figure 4.36 Participants’ Perceptions About the Success of their Projects](image-url)
To identify participants’ motivations to change their current practices, the author asked the participants to comment on how they would describe a successful day in their project. Responses varied from “improve communication and daily commitments accomplishment,” “constraints removal and sharing progress with the team and getting the work done,” “keep a constant work flow,” “zero accidents, zero rework, high productivity,” and “implementing innovative processes”. The common patterns among these responses suggest that stakeholders’ perspectives about a successful day in their projects differ a great deal, which means that there is a misalignment of goals. Therefore, their priorities might be completely different. While some people’s concerns are grounded in improving communication, other members are more focused on productivity-oriented factors, such as avoiding accidents and rework.

The author also asked the participants, “If you could change something in the project, what would it be?” Responses to this question varied from “increase client involvement and accurate communication with client,” “schedule activities with the different disciplines,” “define clear rules when working with the different companies in the group,” “improve contract clauses in order to make it more collaborative instead of aggressive,” “improve constraints analysis and planning process,” “commitment compliance, improve daily planning and share it with the team,” “share project goals more often,” “effective communication,” “involve all stakeholder earlier in the project to elaborate an integrated planning and execution program,” and “planning should consider all different variables that might impact it”. The common patterns among these responses suggest the following:

1. Project teams have realized the need to get the owner involved in the development and execution of their projects. A key characteristic of IPD projects is the level of commitment that the owner contributes to the process. For infrastructure projects in the way of PPP in Peru where the client is the government, there is the figure of an internal client (business developer) who can play the role of the final client. However, there is a need to empower this player to facilitate decision-making.

2. By requesting the clarification of rules, there is a suggestion to improve the company’s contracts and guidelines. Though having an IPD type of contract with the government might be a difficult if not impossible feat under current
legislation, the organization can still work on establishing an internal agreement between its companies to facilitate implementation of key IPD strategies such as sharing risks and rewards and clarify the roles and responsibilities of the core group, clusters and other teams formed in their projects.

3. Even though the company has been implementing Lean tools and especially Last Planner System throughout the organization, basic practices such as constraint analysis still need to be reinforced through training and by encouraging collaboration between the different disciplines to avoid interferences and rework.

The author also aimed to know the number of respondents that would join a project team in the form of IPD with a formal agreement. The study findings show that the participant willingness to sign IPD agreements is relatively high. As shown in Fig. 4.37, around 66% of participants would be willing to try relational agreements, 27% of them are not sure, and only 7% said that they would not sign such an agreement. Even though there is a lack of knowledge in regards of IPD, participants show interest in using this new delivery method.

Figure 4.37 Participants’ Williness to Sign IPD Agreements in Peru
4.10 Plan of Action for Improvement in the Next 15-Year Period

The plan of action proposed by the author started by introducing in the previous section the participants willingness to change the current state of construction industry practices in Peru. The plan of action shall be adjusted based on each company and project particularities and the implementation team shall establish targets for measuring the success or identifying potential additional areas of improvement. There are many measures of success including satisfied clients, a solid safety record, on-time delivery, cost and schedule assurance, and a lack of claims and disputes (Kenig et al., 2010). The success of the implementation shall be defined in consensus based on the stakeholders involved.

4.10.1 Plan for Improvement per Path of Knowledge

Cheng et al. (2011) categorized strategies for IPD into four different categories which are legal and commercial, management, social, workplace and technological strategies. However, even though formal strategies might help, Chen and Manley (2014) highlighted that informal mechanisms fostering integration can be greater predictors or project performance rather than formal mechanisms.

The maximum value that the companies can achieve in the statements included in the questionnaire is 5 points. The expected target per company can vary because they might want to improve certain areas more than others. It is recommendable for assessing IPD implementation in different companies to measure their initial state, set their expected goals per area and keep track of the achievement over time.

Integrated teams pursuing organizational alignment shall focus their efforts in setting strategic goals that are supported in the cultural values of the team.

The plan of action has been divided into three phases of five-years each. As such, each phase starts with the identification of the current state of practice by value stream mapping individual organizations and fostering small wins as small effort that will make improvements more tangible and visual to motivate others.

The 8-step process proposed by Kotter (2002) can be divided into three phases: defrosting the status quo, taking actions that bring about change, and anchoring and sticking changes. Suggestions for improvement are proposed for each of the three phases.
Getting started: Defrost the status quo

- Increase awareness: Share current issues in construction. Include project performance metrics in team meetings for all stakeholders’ knowledge. The use of panels in common areas also helps for sharing important information with the whole team including people working in the field.
- Share opportunities for improvement: Use conceptual framework for making people aware of the available tools and principles that shall govern an integrated project and convince stakeholders to take the necessary steps to adapt the framework. Teach lean thinking and train individuals with appropriate skills.
- Follow organizational changes: Zhang and He (2015) suggested that the reasons for sharing knowledge have moved from *altruism and awards* to *social motivations* such following corporate norms, mimic leaders’ behavior, and the need to reciprocate.
- Ask for help: Garcia et al., (2016) suggested that team monitoring behaviors mediate the relation between team goal alignment and innovation effectiveness. Lean champions are ideal roles needed for companies starting their Lean journey.

Take actions that bring about change:

- Share project metrics: Knapp et al. (2014) suggested that project’s success metrics and targets are displayed and make all the process more visible.
- Use collaboration practices: Common practices supporting collaboration in projects while developing a trusting environment include workshops, benchmarking, constant monitoring, team building sessions, use of external facilitators to help with the process (Sparkling et al., 2016).
- Empower labor: Projects are built by people and following the continuous improvement ideal of Lean construction, it is key that the craft and foremen shall be empowered to improve how their work is performed (Seed, 2014). Seed also highlighted that even though foremen might be experts in their work, they lack expertise on negotiation skills, empathy, and compromise and therefore they shall learn that commitment matters and fostering reliable promising is a must do in integrated projects.
• Create alignment mechanisms: Create an incentive mechanism that foster bottom-up initiatives.

• Set targets and plans to achieve them: Create a goal and metrics matrix for each project in which metrics such team deployment, project quality, safety, cost, and schedule are analyzed. Each goal shall have a target that might depend on the particularities of each project such project scope, unique goals, context and surroundings of the project.

Anchor the changes:

• Emphasize the importance of IPD: Make the changes permanent by stressing the idea that IPD is here to stay and it is not optional anymore.

• Keep training team members: Gupta et al. (2009) suggests that a structured approach to training will help sustaining the desired culture.

• Foster sharing of IPD concepts: A cornerstone for successful IPD implementation in the Peruvian context is making the IPD process better known; therefore, top management shall support and channel the efforts.

• Achieve buy-in from owners: Help owners learn the advantages of IPD and what they shall demand and support the delivery of projects.

The plan of action was developed over a period of several work sessions with the LCI Peru academic committee in which the author participated with updates of the research and discuss ideas for the plan of action with the committee. As a member of the academic committee of LCI Peru, the author reported the findings of the study and use IPD techniques with the team such CBA and LPS to develop the plan of improvement. Some examples are added in picture in subsections such training program and facilitation workshops. Table 4.22 presents the specific tasks per knowledge path to facilitate successful IPD implementation.
<table>
<thead>
<tr>
<th>Time Frame / Areas for Improvement</th>
<th>Specific Tasks and Tools Recommended for Future Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0-3 years</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Wisdom Path                       | - Identify current state of practice and define conditions of satisfaction involving all parties into the discussions.  
                                       - Work along with strategic partners in making people aware about basic IPD concepts through lectures, seminars, papers. Create the role of the lean champion. |
| Strategy Path                     | - Increase the use and awareness of IPD tools. Start with basics such increasing the usage of LPS in projects (which usage received a rate of 1.71/5 in the study). Last planner implementation with an emphasis on pull planning.  
                                       - When co-locating people in person is impractical, use video calls.  
                                       - Set targets for improvement in yearly basis and measure.  
                                       - Use IPD tools to optimize production: First run studies and Value stream mapping.  
                                       - Show team that the project is a “safe zone” where everyone is encouraged to speak up. |
| Mindfulness Path                  | - Introduce the practice of retrospection from the school. Teach a sort of retrospection activities so that people can regularly check their work. |
| Leadership Path                   | - Pay attention to what other team members need and help them to improve by using IPD tools and principles you are aware of.  
                                       - Seek for help whenever is needed.  
                                       - Create an adequate channel to facilitate transfer of information. |
<p>| Integration Path                  | - Take time to learn about each other and be aware that your behavior influences the group. |</p>
<table>
<thead>
<tr>
<th>Time Frame / Areas for Improvement</th>
<th>Specific Tasks and Tools Recommended for Future Use</th>
</tr>
</thead>
</table>
| - Develop performance goals and establish acceptance and criteria.  
- Agreement is reached on tolerance between trades. | **3-10 years** |
| Wisdom Path | - Establish a learning routine and teach while doing.  
- Show initial findings and set a new baseline.  
- Foster flow of feedback and suggestions for improvement. |
| Strategy Path | - Apply appropriate tools and methods. Establish high level of precision.  
- Increase the use and awareness of IPD tools. Increase the usage of A3 in projects (which usage received a rate of 1.68/5 in the study), CBA, VSM, and visual management.  
- Define and agreed upon construction means and methods beforehand.  
- Develop set-based strategy is used to generate, evaluate, and select from design alternatives. |
| Mindfulness Path | - Make retrospection a habit.  
- Ask team members to apply it in different aspects of the project. |
| Leadership Path | - Teach them to learn from breakdowns.  
- Leaders willingness to share shall grow. |
| Integration Path | - Align organizations and teach them to value common goals of the project over their own organization’s goals.  
- Mitigate defensive or guarded behaviors.  
- Administrative documents are integrated into the phases of project definition and lean design, therefore minor effort is required during construction and closeout of the project. |
<table>
<thead>
<tr>
<th>Time Frame / Areas for Improvement</th>
<th>Specific Tasks and Tools Recommended for Future Use</th>
</tr>
</thead>
</table>
| **Wisdom Path**                   | - Improve overall supply chain: Share principles with all the supply chain members and use tools through all phases of the construction project.  
- Set up a new baseline for improvement. Measure current state of the conceptual framework proposed and keep building a culture of learning while doing. |
| **Strategy Path**                | - Increase the use and awareness of IPD tools. Start with increasing the usage of set based design and TVD in projects (which usage received a rate of 1.55/5 in the study). |
| **Mindfulness Path**             | - Share retrospective impact with the community and leverage its advantage.  
- Conduct post occupancy evaluations to measure clients’ satisfaction levels. |
| **Leadership Path**             | - Make IPD leaders master and be able to teach the whole IPD ideal. |
| **Integration Path**             | - Create win-win and lose-lose scenarios a habit.  
- Keep building on trust.  
Create a controlled environment and minimize injuries.  
- Models reflect “as-built” conditions. |

### 4.10.2 Facilitation Workshops to Foster IPD

As Peter Senge (1990) in his book “The Fifth Discipline” said, “People seek change, but do not want to be changed”. Fish (2011) suggested that when implementing a new project delivery method such as IPD, having a facilitator that knows the ins-and-outs of IPD is key for its successful implementation. In addition, Gupta et al. (2009) said that when there are only a few members who have prior experience, it is recommended to have a group of professionals available to help training project team members. Furthermore, Seed (2014) also indicated that IPD projects require leaders who possess group facilitation skills.
Therefore, as IPD is new in the Peruvian construction market, getting help in the process is fundamental and facilitators play an important role understanding such scenario and the critical factors that allow a successful implementation of IPD (Sparkling et al., 2016). It is important that facilitators understand the main barriers that might prevent its proper implementation and have strategies to mitigate them.

Team formation identify team members and team development includes training, assessments, reflection.

Workshops cover a set of topics that shall answer to specific needs according to each organization. Among the key topics common for most organizations is the formation of high performing teams to manage integrated projects. High performing team formation shall consider a process for assembling teams that include (Cheng et al., 2016; Long et al., 2007; AIA, 2007; Sumner and Slattery, 2010):

- Creating a single-team focus on best-for-project and align with the client’s business objectives
- Identification of roles and responsibilities and building a project team that managed the whole project jointly and is committed to deliver value
- Create a learning environment with share values, goals, interests, and objectives
- Challenging paradigms and improve coordination, organization, and direction
- Embracing innovation and lean leadership
- Cost shall be accurate to set and steer to targets
- Perform a validation process in which team is committed to deliver the project under certain specifications.

Do et al. (2005) suggested some important rules for efficient meetings in the big room:

- Make it a safe zone where everyone speaks up and their opinion is important
- Equal status among participants
- No multi-tasking
- Be on time
- Conduct plus/delta sessions

Champions support team success (Cheng et al., 2009) and therefore they can potentially play the role of facilitators. Some of the topics or categories that McKew (2009) proposed that an IPD facilitator shall master are listed below:
- Contracts,
- Communication
- Goal Setting
- Quality Control Process
- Risk Management
- Scheduling (project and occupants)
- Smart/Sustainable Software, BIM/LEED
- Asset Management
- Document Management
- Design-Construct-Operate-Maintain
- Estimating (hard costs and soft costs)
- Procurement and Commissioning

4.10.3 Training Program and Establishment of Learning Routines

Training plays an important role since it helps internalizing and using knowledge (Ghassemi and Becerik-Gerber, 2011; Hartmann et al., 2010; Walker and Lloyd-Walker, 2011). Do et al., (2015) training will promote and develop a lean culture. Also, Ghassemi and Becerik-Gerber, (2011) highlighted training as a key factor for a successful transition to IPD and it can happen at the organizational and at the project level. (Thomsen et al., 2010) some authors recommend facilitating retrospective sessions in which team members can reflect on past and present situations and act for improving their effectiveness and efficiency, others suggest the importance of developing workshops and training sessions for getting members involve with new processes (Zipf, 2000).

Training sessions can be developed in different ways such having a one-day course about the basics of IPD, or a set of activities that the project team shall perform as the project progresses (Ghassemi and Becerik-Gerber, 2011) or as it is suggested in this study creating a certified program that consists on different sessions that cover a set of topics related to IPD and Lean Construction.

The training program would follow a 70/20/10 methodology which involves companies learning from hands-on experience. Learning routines need to be embraced. Drastic
changes are occurring in the way companies compete in the construction industry. In order to keep pace with industry requirements, it is critical for companies to train their people in soft and technical areas. Each company might identify those who require training.

The researcher as part of the LCI Peru Academic Committee is working in a joint effort with the committee members in developing a training program to have people trained and certified in Lean construction. Figure 4.38 shows a screenshot of the collaborative panel used by the author while developing the training program with LCI Peru Academic Committee.

![Figure 4.38 Trello Panel to Collaboratively Develop the Training Program](image)

### 4.10.4 Communities of Practice in Peru

The role of LCI Peru in fostering Lean and IPD in construction is key as it is the leading institution in Peru in charge of promoting Lean thinking. As Do et al. (2015) said, communities of practice groups often invite experts outside to come in to present to the group specific topics related to Lean. Thomsen et al. (2009 pg. 29) said that “a community of practice refers to a group of people who share a concern, interest or a passion for something and it gives members a sense of joint enterprise and identity they do and then develop further proficiency as they practice and regularly interact”.

4.11 Summary and Discussion

The research expanded on the analysis of the potential application of the conceptual framework proposed in chapter 3. Canales (2014) was also interested in investigating the potential application of IPD in other countries from Latin America such as Colombia. In this case, the author developed an extensive analysis of IPD applicability in Peru. Two analyses are developed in this chapter, the first analysis was focused on a study case with a company with expertise in Lean construction and targeting to build an IPD project for the first time in Peru. The second analysis expanded its scope and study trends in the Peruvian construction industry to analyze IPD feasibility in the market. Lately, the author along with LCI Peru academic committee developed a plan of action for improvement based on findings from the case study (phase 2) and the expanded survey (phase 3). Previous studies suggest that tools included in the conceptual framework such as co-location, on-boarding, A3, and CBA can potentially impact a successful implementation of IPD in projects (Cheng 2016); in such context, this research benchmark the current state of application of such tools and aim to improve it. Different topics such as the use of certain tools and application of integrated principles had been described in detail and some questions are left opened for further discussion such as how to better build long-term relations and accelerate the buy in process from clients about IPD in Peru.

4.12 Conclusions

The author conducted a qualitative analysis through a case study in which the author analyzed the applicability of the framework and captured the participants perception and related experience with IPD. Main data was provided by LCI Peru containing perceptions from professional in the AEC industry who have experience on infrastructure projects or are currently involved in the case study analyzed in the research. By analyzing the data collected through LCI Peru, the author identified current practices in Peruvian construction industry to analyze feasibility of IPD implementation. The research reported in this study explored practical nuances of IPD, current state of the construction of infrastructure projects in Peru versus the ideal state capture in the conceptual framework for implementing IPD, and what would need to change to further
promote collaboration in the context of Peru. This research allows for a greater understanding of IPD implementation and the potential applicability within infrastructure projects in Peru. The collaborative approach aims to meet higher service levels and improve the current process for design, construct and operation of infrastructure projects. For example, even though most of the participants in the case study (89%) are aware of the Last Planner System, there seems to be considerable opportunity to start using the big room effectively, while there is also a need to establish an on-boarding process for the whole team.

A comparison of the proposed conceptual framework and the current state of construction in Peru through the principles, tools, and governance structure that facilitate IPD implementation show the opportunities for improvement and how the industry can close the gap from traditional approaches, leading to propose potential steps that organizations shall take in order to integrate their projects. Suggestions for improving current practices for construction of infrastructure projects might include improving the selection of project parties.
5. CONCLUSIONS

5.1 Discussion

Integrated project delivery (IPD) is still a newly delivery model in Latin American countries. Forero et al. (2015) studied the application of IPD in Colombia, a country with similar characteristics to Peru, and suggested that a great majority of the stakeholders participating in their study agreed that the construction industry requires mechanisms to deliver projects more effectively. Also, they stated in the same study that the fear of change is one of the main barriers that inhibits change because some people consider changes unnecessary or dangerous. In such context, Canales (2014) reported similar issues in the construction industry in Peru and argued that such issues might be related to the lack of integration and alignment of stakeholders’ goals. This research investigated the perceptions that participants who are related to the construction of infrastructure projects in Peru have towards the implementation of IPD principles and tools in public projects based on Peruvian cultural nuances and the current state of construction practices in Peru. To achieve integration in Peruvian construction industry, change in current practices is needed. This includes, focusing on building and maintaining long-term relations. In the analysis, the author proposes a conceptual framework with a structure which IPD principles and tools that should be implemented in Peru. Open questions left from the study might include defining the right time when to bring participants to the table and how to better foster and accelerate the buy in process about IPD as a catalyst for improving the current state of construction.

The author also discussed points such as the understanding of the definition of “respect” by participants. It may be hypothesized that the culture of survival identified in the sample case study might prevail in the Peruvian construction industry, but this hypothesis was not proved neither negated in the study. In case this hypothesis is validated in future studies, it would be important to know how can people build respect in an industry that has been seriously damaged with corruption nowadays? As Medina (2014) said, mistrust governs the construction industry history in Peru and this research findings support Medina’s
premise about the need of creating mutual respect and a positive environment in construction in Peru to make IPD sustainable.

Also, a question that remains open is if there is any relation between open communication and effective communication? While the level of communication might be acceptable according to the participants, it may not be through the most effective channels. In the case study it was observed that despite the efforts on implementing the practice of co-locating parties, communication did not flow as expected.

Lastly, even though the author captured a functional governance structure for IPD projects in general, it is worth noting that since project structures highly vary among countries. Therefore, the critical role of superintendents in the United States need to be adapted in some way in countries such as Peru since it is not clear who in the project shall assume that role; for instance, based on the author’s experience, the tasks that superintendents in the United States perform are a combination of what the field engineer and the general foreman in a project in Peru do as their responsibilities.

5.2 Conclusions

Because of the increase in complexity of construction projects and the current trend towards integrated approaches in construction, the author developed a detailed study about the applicability of integrated project delivery (IPD) for infrastructure projects in Peru. This study provides information and an overview on integrated project delivery (IPD) as project delivery method while proposing a conceptual framework for IPD implementation. Conclusions and findings are divided in 4 different phases i) understanding the reasons for proposing IPD as a solution for dealing with current challenges in construction, ii) summarizing key factors that facilitate successful implementation of IPD in a conceptual framework, iii) analyzing the applicability of IPD in Peru based on current practices and the ideas proposed in the framework, and iv) suggesting a plan of action for improvement based on current state of practices in Peru. A list of the research findings is provided for each part of the study. The conclusion of the work is a conceptual framework for successful implementation of IPD in infrastructure projects in Peru, an analysis of the current state of construction of infrastructure projects in Peru and a proposal of steps that shall be taken to transition to IPD based on participant’s perspectives.
The need for IPD in the construction industry:
Integration is urgent in the light of more new specialist disciplines emerging and the engagement of participants in earlier stages of the project. It has been proven that IPD is capable of enhancing the delivery of projects in terms of project performance, sustainability, and work environment at the individual, team, and organizational level. Therefore, IPD has attracted attention from the AEC industry and it is key to assure its successful implementation to improve project delivery. Primary data for the study was collected through a systematic analysis of the existing body of knowledge. Study findings not only reinforce the need to foster integration in the construction industry, but also highlight key factors (principles, tools, governance structure) for IPD implementation. Key takeaways of this section are:

- Complexity is seen as a catalyst for moving to a collaborative approach. Even though a complex project may be more unpredictable and challenging, the high level of complexity of infrastructure projects may act as a catalyst to motivate a disruption in the dynamics of project teams towards more integration.
- Integration has become a must have characteristic for success in construction.
- The collaborative approach aims to meet higher service levels and improve the current process for design, construction, and operation of infrastructure projects.

Factors that facilitate a successful implementation of IPD:
The data from the systematic literature review was examined in detailed to deeply understand IPD and create the conceptual framework proposed by the author. The author, as a result of this research, added to the body of knowledge a framework to assist project teams and facilitate IPD implementation to deliver higher value to clients of infrastructure projects by using an integrated delivery system. This guideline outlines how to break through the old traditional delivery methods in construction and enter into a collaborative, integrated approach. Such collaborative approach is fostered through the use of the conceptual framework which includes different layers interrelated and enhance one each other and suggests that the following principles, tools, and suggested governance structure would facilitate IPD implementation. Key notes that form part of this section are:
• The conceptual framework proposed provides a guideline for IPD implementation that could be used on any construction project with specific adjustments according to each project particularities.

• The framework allows those who have little or no experience in IPD to get a better understanding on what it involves, how it works, what principles govern an integrated project, which tools facilitate its implementation, and what an amenable governance structure is that support IPD successful and sustainable implementation.

• By fostering an integrated approach within teams, participants will gain a better understanding of other disciplines.

• There are several rules that can be applied to improve co-locating practices and manage big room meetings such as (1) safe zone sense, (2) your opinion is important (3) all equal status; (4) and others (Do et al., 2015).

Analyzing IPD feasibility for infrastructure projects in Peru:
Since there has been little research to date on analyzing the applicability of IPD in Peru; therefore, this study contributes to the body of knowledge in construction by proposing a conceptual framework for IPD implementation. The author conducted a qualitative analysis through a case study in which the author analyzed the applicability of the framework and captured the participants perception and related experience with IPD. Main data was provided by LCI Peru containing perceptions from professional in the AEC industry who have experience on infrastructure projects or are currently involved in the case study analyzed in the research. By analyzing the data collected through LCI Peru, the author identified current practices in Peruvian construction industry to analyze feasibility of IPD implementation.

The research reported in this study explored practical nuances of IPD, current state of the construction of infrastructure projects in Peru versus the ideal state capture in the conceptual framework for implementing IPD, and what would need to change to further promote collaboration in the context of Peru. This research allows for a greater understanding of IPD implementation and the potential applicability within infrastructure projects in Peru. The collaborative approach aims to meet higher service levels and improve the current process for design, construct and operation of infrastructure projects.
A comparison of the proposed conceptual framework and the current state of construction in Peru through the principles, tools, and governance structure that facilitate IPD implementation show the opportunities for improvement and how the industry can close the gap from traditional approaches, leading to propose potential steps that organizations shall take in order to integrate their projects. Suggestions for improving current practices for construction of infrastructure projects might include improving the selection of project parties. The findings of the survey provide important information about the current state of the art in IPD in Peru and the overall drivers for change. A later analysis is performed to determine whether the Peruvian context would be suitable for implementing the conceptual framework in the next 15 year or what extent of accomplishment will be expected. A summary of findings in this section include:

- Even though Peru faces issues that seem to be characteristics of every place where construction is done, the different cultural settings (motivation and barriers) from country to country might require different triggers for generating collaboration and what might vary in fact is the process that will be adopted to achieve the required level of integration.
- Considering each project characteristics, teams can implement some or all the propositions included in the conceptual framework.
- The current state where a culture of survival prevails need to be transformed by adopting a collaborative approach which will change people’s mindset with a focus on respect for people. Accountability, trust, and respect need to be strengthened and making/keeping real commitments would support it. However, trust and respect might imply different behavioural patterns in different institutional contexts. The company under study has started a leadership program to reinforce the concept of respect as a recognized sovereign right of people to think differently.
- Lean principles and methods can be applied to a wide range of processes without prior regulative structures.
- Mitigating the lack of knowledge regarding IPD in Peru requires more effort in training people to better understand the concept. The training process might increase awareness of potential use of tools that facilitate IPD. Even though the participants have started collaborating early in the construction process, the
multidisciplinary teams can improve the integration practices by using tools such as A3, CBA, and PDCA.

- Organization can facilitate the application of IPD tools and principles by fostering the main behaviors that enable its implementation. Also, by creating a team within the IPD structure governance, attitudes such team alignment and improved communication will be encouraged.

**Plan of action to foster IPD implementation in Peru:**

Finally, the study includes a guideline for potential improvements in the way projects are executed. The goal is to deliver a facility that meets owners’ needs. For the improvement process, there are 5 different paths for improvement in which the plan of action is divided. Each path suggestions are listed below as part of the findings. The author proposed a plan of action to minimize or eliminate such challenges placing a closer attention to specific principles and tools to implement in the short-term and long-term vision of change.

Although the research was intended to be focused on the implementation of IPD for infrastructure projects in Peru, the parameters evaluated for establishing the benchmark and propose improvement could be used and adapted with slight changes to other areas of the construction industry.

- **Wisdom path areas of improvement:** Work on time management and create a learning environment since participants stated that they do not usually make time to keep learning Lean principles and also if they do not have time, no effort is done on their side to keep learning such principles. Incentivize continuous learning is key to improve the rating in this path which has potential areas to improve such make sure participants gather information regarding IPD from different sources, include a space in the training program where facilitators make people aware of the low rates obtain in this section and set targets and a plan for improving each.

- **Mindfulness path areas of improvement:** Results directly emphasize the lack of knowledge regarding retrospective activities. It is important in integrated teams to constantly check participants performance not with the idea of finding who is doing something wrong, but with the willingness to find what individuals shall improve. Outcomes also showed that participants do not find time in their daily activities to
perform retrospection; therefore, IPD leaders shall include in their plan how to motivate and encourage participants to perform retrospection activities and create such moments to begin a common practice.

- Leadership path areas of improvement: The most notorious area to improve in the leadership path involves the leader helping team members to implement Lean more often. There is a sense among participants that leaders shall be more committed on sharing what they know in regard to Lean principles and tools. Results show that leaders are motivated and want their team member to be able to manage IPD principles and tools with high frequency; however, there remains a small percentage of leaders who participated in the study and do not have any incentive in their team members learning such integrated practices.

- Integration path areas of improvement: The study shows that participants need to take time to learn about each other and establish strong relations which in turn would create trust. A strength that is worth noting in this path is that team members are well aware that they are part of a team and that their behavior influences the whole group.

- Strategy path areas of improvement: Perhaps the path which requires more focus in the strategy path which involves the use of IPD tools. Results of the study show that even though most participants have heard about various IPD tools, the level of knowledge participants have is very basic since very few of them considered that they do not master IPD tools yet neither they recognize best practices related to such tools nor use them often. S

- Work on basics: According to the participants perception, there is a need to improve reliability in the projects. Therefore, the planning process need to be improved. There’s a sense that people are still doing “push” in some projects and not removing constraints properly. The author recommends start redesigning the production system considering different disciplines requirement of involved parties.

- Implementing a training program: In order to improve understanding of IPD capabilities, training is needed in principles, tools and methods that facilitate IPD implementation. The maturity of IPD implementation will grow as the concept is diffused. With the training program proposed, team members will get engage with
concepts included in the conceptual framework. The aim is to apply such concepts consistently and with discipline.

- Practices such as visual management may need to be implemented to facilitate communication of co-located parties. It is also interesting to explore how trust will influence predisposition of people to share risks and rewards. Some steps for improvement have been suggested such as reinforcing the use of LPS to improve reliability and foster training programs in TVD to set and steer to targets in integrated projects.

- Commercial terms: As some participants had realized, the construction industry need to work on improving commercial terms to sustain IPD. The study analyses the application of IPD principles with no standards contract agreements. The author suggests that the parties involved construct their own contractual agreements in order to overcome the obstacle to improvement and innovation, which is ‘Who pays? Who gains?’. As a fundamental principle, shared risk and reward is essential in order for the different companies to give permission to their employees to collaborate with the employees of other companies and encourage them to do so.

5.3 Limitations

Despite the implications of these findings, there are several limitations in the study. The author created a database of papers found through internet and added other sources from practitioners and experts in English, sources in other languages were not considered in the analysis. For assessing the current construction industry in Peru, the researcher used data collected through the Lean Construction Institute – Peruvian Chapter (LCI Peru). As part of the research, LCI Peru conducted two surveys that were developed in different stages of the study. Due to the limited number of experience in IPD in Peru, the author developed a qualitative investigation in the subject. The study only included data from one company case study, which is the most experienced using Lean construction. Results of this study should not be generalized, rather the findings should be used to give an overview of IPD implementation in Peru. For the first round of surveys, the researcher used data from only one company, the same in which the case study was developed. The company under study is currently one of the largest construction companies and with the most experience using
Lean construction in Peru. The second round of the surveys included a larger group of participants from the LCI Peruvian Chapter and the author assessed data regarding motivation, effort, knowledge, and awareness of participants to analyze the feasibility of applying the proposed framework for implementing IPD in infrastructure projects in Peru that is suggested in this research. It is important to highlight also that the sample do not have statistical significance due the limited time and number of people participating in the study. However, results of this study should not be generalized before a process of testing and refinement is done in future research, rather the findings should be used to give an overview of what efforts had been done in regards of IPD implementation in Peru and use a guideline for a successful implementation to sustain an integrated approach. Even though Peru faces issues that seem to be characteristics of every place where construction is done, the different cultural settings (motivation and barriers) from country to country might require different triggers for generating collaboration and what might vary in fact is the process that will be adopted to achieve the required level of integration.

This research does not attempt to address all aspects of IPD that will secure a successful implementation, but rather offers a guide for a market in Peru with not much knowledge regarding IPD and its implications. The resources and time of this research were limited. The research did not examine legal regulations for public projects in Peru. However, it focused strictly on identifying the current application in practice of IPD and how it can be adopted into the Peruvian construction sector.

The main problem for analyzing the suitability of the conceptual framework proposed by the author is that no one in the country had ever implemented IPD as a delivery method for construction and there is a considerable lack of knowledge of such approach in the market. However, the author documented through the case study the first attempt to use IPD for the construction of an infrastructure project.

5.4 Recommendations for Future Research

The research highlights areas that could benefit from further research such the impact of training on fostering integrated approaches in construction. Also, future research shall include the study of the impact on investment in education on IPD concepts and training
participants in new tools and how LCI Peru community of practice help achieving such
goals towards the creation of students’ chapter in the universities.
Further studies can refine the model by identifying certain relations or influence between
the use of tools to foster the adoption of principles and creation of a culture as a long-term
goal. Similarly, future effort shall include the development of certain metrics to assess and
examine in detail how relations will be changing over time as the conceptual framework is
implemented and guide the behavior of team members towards integration. By using
specific metrics for measuring certain parameters, the organizations can get a diagnostic
and set their plans accordingly by benchmarking their current state and constantly reflect
on current practices using retrospective activities. For such purpose, creating routines and
standardizing the use of templates and guidelines to evaluate the state and set new
benchmarks will help in the process.
Lastly, it is key to analyze deeply the role of the government in leading the construction
industry towards more integrated practices. It requires more attention since public agencies
are being mandated by the country’s current legislation and norms should be modified
based on actual needs to better use public funds for the wellbeing and reconstruction of the
nation.
APPENDIX A. QUESTIONS INCLUDED IN SURVEY USED TO IDENTIFY STATUS OF CONSTRUCTION PRACTICES RELATED TO IPD IN THE CASE STUDY IN PERU

Answer questions as per requested in each statement: / Responda a las preguntas según se le pide en cada oración:

<table>
<thead>
<tr>
<th>Low complexity</th>
<th>High complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What is the level of complexity of your project?</th>
<th>¿Cuál es el nivel de complejidad de tu proyecto?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Completely disagree / Completamente en desacuerdo</td>
<td></td>
</tr>
<tr>
<td>5 = Completely agree / Completamente de acuerdo</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IPD is a different way of doing things.</th>
<th>IPD es una forma diferente de hacer las cosas</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPD helps to create trust.</td>
<td>IPD ayuda a crear confianza</td>
</tr>
<tr>
<td>Every member is well represented (Between teams and partners).</td>
<td>Cada miembro está bien representado (Entre equipos y empresas)</td>
</tr>
<tr>
<td>My relationship with other companies of the group is good.</td>
<td>Mi relación con las otras empresas es buena</td>
</tr>
<tr>
<td>I can make big changes.</td>
<td>Puedo hacer grandes cambios</td>
</tr>
<tr>
<td>I feel empowered.</td>
<td>Me siento empoderado</td>
</tr>
<tr>
<td>I am an essential part of the team.</td>
<td>Soy una parte esencial del equipo</td>
</tr>
<tr>
<td>Project objectives are clear and understood by all parties.</td>
<td>Los objetivos del proyecto son claros y entendidos por todas las partes</td>
</tr>
<tr>
<td>I understand other companies expectations.</td>
<td>Entiendo las expectativas de otras empresas</td>
</tr>
</tbody>
</table>

207
<table>
<thead>
<tr>
<th>English</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the team committed to solve problems for the best on the project</td>
<td>El equipo está comprometido a resolver problemas en el mejor interés del proyecto sin importar intereses individuales</td>
</tr>
<tr>
<td>besides individual interests?</td>
<td></td>
</tr>
<tr>
<td>My job benefits the team.</td>
<td>Mi trabajo beneficia al equipo</td>
</tr>
<tr>
<td>We work better as a team.</td>
<td>Nosotros trabajamos mejor como equipo</td>
</tr>
<tr>
<td>I understand the project’s success metrics.</td>
<td>Entiendo las métricas de éxito del proyecto</td>
</tr>
<tr>
<td>All stakeholders agree and are aligned with the objectives of the project.</td>
<td>Todos los involucrados están de acuerdo y alineados con los objetivos del proyecto</td>
</tr>
<tr>
<td>My company objectives are aligned with the group’s objective.</td>
<td>Los objetivos de mi empresa están alineados con los objetivos del equipo</td>
</tr>
<tr>
<td>Team members are committed to accomplish common goals.</td>
<td>Los miembros del equipo están comprometidos a cumplir los objetivos en común</td>
</tr>
<tr>
<td>Team members help to integrate new members.</td>
<td>Los miembros del equipo ayudan a que nuevos miembros se integren</td>
</tr>
<tr>
<td>I can feel chemistry in my project team.</td>
<td>Puedo sentir la química en mi equipo de proyecto</td>
</tr>
<tr>
<td>Team shows consideration to new members.</td>
<td>El equipo muestra consideración hacia nuevos miembros</td>
</tr>
<tr>
<td>No one is more important than others.</td>
<td>Nadie es más importante que otros</td>
</tr>
<tr>
<td>The team wants to hear my voice.</td>
<td>El equipo quiere escuchar mi voz</td>
</tr>
<tr>
<td>I am satisfied with the communication with my supervisor.</td>
<td>Estoy satisfecho con la comunicación con mi jefe o supervisor</td>
</tr>
<tr>
<td>I can speak up about anything.</td>
<td>Puedo hablar de cualquier cosa</td>
</tr>
<tr>
<td>I see a commitment to safety.</td>
<td>Veo un compromiso con la seguridad</td>
</tr>
<tr>
<td>English</td>
<td>Spanish</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>There is a bottleneck in sharing information.</td>
<td>Hay un cuello de botella para compartir la información</td>
</tr>
<tr>
<td>We do things better by sharing ideas.</td>
<td>Hacemos mejores cosas compartiendo ideas</td>
</tr>
<tr>
<td>We do a great job in sharing information in the project.</td>
<td>Hacemos un gran trabajo compartiendo información en el proyecto</td>
</tr>
<tr>
<td>We do a great job in sharing information between projects.</td>
<td>Hacemos un gran trabajo compartiendo información entre proyectos</td>
</tr>
<tr>
<td>IPD helps to improve communication.</td>
<td>IPD ayuda a mejorar la comunicación</td>
</tr>
<tr>
<td>We organize innovation meetings as a best practice.</td>
<td>Organizamos reuniones de innovación como mejores prácticas</td>
</tr>
<tr>
<td>I see value in the weekly innovation meetings.</td>
<td>Veo valor en las reuniones semanales de innovación</td>
</tr>
<tr>
<td>Our team is committed to continuous improvement.</td>
<td>Nuestro equipo está comprometido a la mejora continua</td>
</tr>
<tr>
<td>The weekly meetings add value to the project.</td>
<td>Las reuniones semanales agregan valor al proyecto</td>
</tr>
<tr>
<td>Team members listen to each other.</td>
<td>Los miembros del equipo se escuchan entre sí</td>
</tr>
<tr>
<td>We share risks and rewards</td>
<td>Nosotros compartimos riesgos y beneficios</td>
</tr>
<tr>
<td>I know other companies’ success metrics.</td>
<td>Conozco las métricas de éxito de las otras compañías</td>
</tr>
<tr>
<td>I am part of the decision-making process.</td>
<td>Soy parte del proceso de toma de decisiones en el proyecto</td>
</tr>
<tr>
<td>Superintendents are key in the decision-making process.</td>
<td>Los superintendentes son clave en el proceso de toma de decisiones</td>
</tr>
<tr>
<td>I know and have used CBA to choose the best options for the project.</td>
<td>Sé y conozco la herramienta CBA para elegir las mejores alternativas para el proyecto</td>
</tr>
<tr>
<td>I am part of a community of thinkers.</td>
<td>Soy parte de una comunidad de pensadores</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Team members collaborate to solve problems.</td>
<td>Los miembros del equipo colaboran para resolver problemas</td>
</tr>
<tr>
<td>I look for support from the community to solve problems.</td>
<td>Busco apoyo de la comunidad para resolver problemas</td>
</tr>
<tr>
<td>I clearly understand and use the A3 tool for problem-solving.</td>
<td>Entiendo claramente y uso la herramienta A3 para resolver problemas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What is your level of familiarity regarding Lean?</th>
<th>¿Cuál es el nivel de familiaridad con Lean?</th>
<th>I don't know about it</th>
<th>I know a little bit about it</th>
<th>I know, and I use it</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your level of familiarity regarding BIM?</td>
<td>¿Cuál es el nivel de familiaridad con BIM?</td>
<td>I don't know about it</td>
<td>I know a little bit about it</td>
<td>I know, and I use it</td>
</tr>
<tr>
<td>What is your level of familiarity regarding IPD?</td>
<td>¿Cuál es el nivel de familiaridad con IPD?</td>
<td>I don't know about it</td>
<td>I know a little bit about it</td>
<td>I know, and I use it</td>
</tr>
</tbody>
</table>

Please select the essential factors for successful IPD implementation (Choose all that apply and add more if needed): Seleccionle los factores esenciales para implementar IPD (marque todas las que considera o agregue opciones a la lista):

| Leadership | Liderazgo |
| Commitment | Compromiso |
| Mutual benefit | Beneficios mutuos |
| Shared governance | Gobierno compartido |
| Responsibility | Responsabilidad |
| Common objectives | Objetivos en común |
| Honesty | Honestidad |
| Empowerment | Empoderamiento |
| Integrity | Integridad |
| Leadership | Liderazgo |
| Respect | Respeto |
What factors were considered for choosing key partners for the project? | ¿Cuáles fueron los factores que consideraron para elegir a los otros miembros del equipo / subcontratistas?
--- | ---
Designers | Diseñadores
General Contractor | Contratista general
MEP Contractor | Contratista MEP
Structural Contractor | Contratista estructural
O&M Contractor | Contratista de O&M

**Options:**

- Cost
- Technical proposal
- Design
- Expertise
- Interview

---

Which parties participated in setting the objectives of the project? | ¿Quién participó en el establecimiento de metas para el proyecto (marque todas las que correspondan)?
--- | ---
Designers | Diseñadores
General Contractor | Contratista general
MEP Contractor | Contratista MEP
Structural Contractor | Contratista estructural
O&M Contractor | Contratista de O&M
Client | Cliente
Civil Contractor | Contratista civil
Finishing Contractor | Contratista de acabados
End user | Usuario final

---

In which phase of the project was feedback from end users taken into account? | ¿En qué etapa del proyecto se usó feedback del usuario final?
--- | ---
Project definition | Definición del proyecto
Design | Diseño
Pre-construction | Pre-construcción
Construction | Construcción
O&M | O&M
Did not use feedback | No se usó el feedback
The processes used in this project in comparison with my previous project are:

<table>
<thead>
<tr>
<th>Similar to previous projects</th>
<th>Mejorado con respecto a mis proyectos anteriores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved compared to last projects</td>
<td>Mejorado con respecto a los últimos proyectos</td>
</tr>
<tr>
<td>Best practices worldwide</td>
<td>Mejores prácticas mundiales</td>
</tr>
</tbody>
</table>

The main barriers for people to innovate in the project are:

<table>
<thead>
<tr>
<th>Fear of change</th>
<th>Miedo al cambio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to change</td>
<td>Resistencia al cambio</td>
</tr>
<tr>
<td>Investment needed for investigation</td>
<td>Inversión necesaria para investigar</td>
</tr>
<tr>
<td>Lack of knowledge regarding innovations around the world</td>
<td>Falta de conocimiento de mejores prácticas en el mundo</td>
</tr>
<tr>
<td>Fear that innovation might cause money loses</td>
<td>Miedo a que la innovación traiga pérdidas de dinero al proyecto</td>
</tr>
</tbody>
</table>

Do you believe early involvement of stakeholders adds value to your project?

| Yes | Sí |
| No | No |
| I do not know | No lo sé |

Choose in which phases of the project the stakeholders had been co-located?

| Design | Diseño |
| Early planning | Etapa de planeamiento del proyecto |
| Before 50% of construction | Antes del 50% de construcción del proyecto |
| After 50% of construction | Después del 50% de construcción |
| O&M | O&M |

**Stakeholders:**

<p>| Client | Diseñador |
| General contractor | Contratista general |
| MEP contractor | Contratista MEP |
| Structural contractor | Contratista estructural |
| Finishing contractor | Contratista de acabados |
| O&amp;M contractor | Contratista de O&amp;M |</p>
<table>
<thead>
<tr>
<th>Did you have incentives for performance included in your contract?</th>
<th>¿Usó incentivos de performance incluidos en su contrato?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Sí</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which parties participated in the decision-making process?</th>
<th>¿Quién participó en el proceso de toma de decisiones en el proyecto (marque todas las que correspondan)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designers</td>
<td>Diseñadores</td>
</tr>
<tr>
<td>General Contractor</td>
<td>Contratista general</td>
</tr>
<tr>
<td>MEP Contractor</td>
<td>Contratista MEP</td>
</tr>
<tr>
<td>Structural Contractor</td>
<td>Contratista estructural</td>
</tr>
<tr>
<td>O&amp;M Contractor</td>
<td>Contratista de O&amp;M</td>
</tr>
<tr>
<td>Client</td>
<td>Cliente</td>
</tr>
<tr>
<td>Civil Contractor</td>
<td>Contratista civil</td>
</tr>
<tr>
<td>Finishing Contractor</td>
<td>Contratista de acabados</td>
</tr>
<tr>
<td>End user</td>
<td>Usuario final</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In which decisions were the different stakeholders involved in the project?</th>
<th>¿En qué decisiones fueron involucrados los diferente stakeholders del proyecto?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Alcance</td>
</tr>
<tr>
<td>Cost</td>
<td>Cost</td>
</tr>
<tr>
<td>Schedule</td>
<td>Plazo</td>
</tr>
<tr>
<td>Change orders</td>
<td>Órdenes de cambio</td>
</tr>
<tr>
<td>Interferences</td>
<td>Interferencias</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which tools have been used in the project?</th>
<th>¿Cuáles fueron las herramientas usadas en el proyecto?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last planner system</td>
<td>Last planner system (LPS)</td>
</tr>
<tr>
<td>Prefabrication</td>
<td>Prefabricación</td>
</tr>
<tr>
<td>BIM</td>
<td>BIM</td>
</tr>
<tr>
<td>A3 thinking</td>
<td>A3</td>
</tr>
<tr>
<td>PDCA</td>
<td>PDCA</td>
</tr>
<tr>
<td>Visual management</td>
<td>Gestión visual</td>
</tr>
<tr>
<td>Onboarding session</td>
<td>Sesiones de onboarding</td>
</tr>
<tr>
<td>Target value design</td>
<td>Target value design</td>
</tr>
<tr>
<td>Co-location</td>
<td>Co-location</td>
</tr>
<tr>
<td>Which factors contributed to project performance?</td>
<td>¿Cuáles fueron los factores que han contribuido al performance del proyecto?</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Co-location</td>
<td>Co-location</td>
</tr>
<tr>
<td>Client leadership</td>
<td>Liderazgo del cliente</td>
</tr>
<tr>
<td>Onboarding</td>
<td>Onboarding</td>
</tr>
<tr>
<td>Relational agreements</td>
<td>Contratos relacionados</td>
</tr>
<tr>
<td>Safety</td>
<td>Seguridad</td>
</tr>
<tr>
<td>Early involvement</td>
<td>Involucramiento temprano</td>
</tr>
<tr>
<td>Communication</td>
<td>Comunicación</td>
</tr>
<tr>
<td>Estimated budget</td>
<td>Presupuesto estimado</td>
</tr>
<tr>
<td>Strategy</td>
<td>Estrategia</td>
</tr>
<tr>
<td>Team</td>
<td>Equipo</td>
</tr>
</tbody>
</table>
APPENDIX B. ASSESSMENT REGARDING IPD PRACTICES IN PERU SURVEY

Questions included in the survey in phase 3 of the research.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Usually</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I take time to learn Lean Principles, I gather information from different sources.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I make time to keep up with Lean Principles by regularly learning.</td>
<td></td>
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</tr>
<tr>
<td>Even if I don’t have time, I make an effort to learn the Lean Principles.</td>
<td></td>
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<tr>
<td>When I can’t understand aspects of the Lean Principles, I reach out to our Lean champion for help.</td>
<td></td>
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</tr>
<tr>
<td>When learning about Lean Principles, I try to implement them as often as I can.</td>
<td></td>
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</tr>
<tr>
<td>I think I will be able to use what I learn from this project on other projects.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>One of the most satisfying things for me is to develop a deep understanding of the Lean Principles.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Developing a strong knowledge of Lean principles is really valuable for me.</td>
<td></td>
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<tr>
<td>Even though Lean principles are new to me, I believe I'm doing well in my learning path.</td>
<td></td>
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<tr>
<td>I rarely find time to perform retrospective activities.</td>
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<tr>
<td></td>
<td>Never</td>
<td>Sometimes</td>
<td>Often</td>
<td>Usually</td>
<td>Always</td>
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<td>-----------------------------------------------------------------</td>
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<tr>
<td>I have a strong knowledge on what retrospective activities are.</td>
<td></td>
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</tr>
<tr>
<td>I could make a stronger effort to perform retrospective activities.</td>
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<tr>
<td>I try to implement retrospection as often as I can.</td>
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<tr>
<td>I make sure I keep up with my performance by regularly checking my work.</td>
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<tr>
<td>I believe I’m doing well in performing retrospective activities.</td>
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<tr>
<td>I believe that performing retrospective activities bring great value.</td>
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<tr>
<td>I try to apply retrospective activities in the various aspects of the project.</td>
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<tr>
<td>I make time in my agendas for retrospection of my own work.</td>
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<tr>
<td>I pay attention to the team members that need help.</td>
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<tr>
<td>When I can’t deliver, I seek help from my team.</td>
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<tr>
<td>When my team is confronted with a breakdown, I work hard with them in resolving the conflict.</td>
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<tr>
<td>I help my team members in implementing Lean principles, as often as I can.</td>
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</tr>
<tr>
<td>I help my team members in implementing Lean principles, as often as I can.</td>
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<tr>
<td>We take time to learn about each other (e.g.</td>
<td></td>
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<tr>
<td>where we are from, hobbies, etc.).</td>
<td>Never</td>
<td>Sometimes</td>
<td>Often</td>
<td>Usually</td>
<td>Always</td>
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<tr>
<td>I'm aware that my behavior influences the group.</td>
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<tr>
<td>I feel that I am part of the team, rather than a just a hired specialist.</td>
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<tr>
<td>I think my team values the common goals of the project over their own organization's goals.</td>
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<tr>
<td>We are willing to sacrifice the team's goals for our own personal goals.</td>
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<tr>
<td>We tend to be defensive or guarded when discussing the project's issues.</td>
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</tbody>
</table>

I'm confident I have a master level knowledge about the following concepts and techniques.

<table>
<thead>
<tr>
<th>Conditions of Satisfaction</th>
<th>I've heard about it</th>
<th>I've used it</th>
<th>I use it often</th>
<th>I recognize best practices</th>
<th>I can teach it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitation</td>
<td></td>
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<tr>
<td>Value to Customer</td>
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<tr>
<td>VSM</td>
<td></td>
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<tr>
<td>Set Based Design</td>
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<tr>
<td>CBA</td>
<td></td>
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<tr>
<td>PDCA</td>
<td></td>
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<tr>
<td>Visual Management</td>
<td></td>
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</tr>
</tbody>
</table>

I think I have strong knowledge about the following techniques:

<table>
<thead>
<tr>
<th>Master Planning</th>
<th>Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Usually</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Huddles</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Look Ahead Planning</td>
<td></td>
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<tr>
<td>Weekly Work Planning</td>
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</tr>
<tr>
<td>Make-Ready Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


Griffith, A. F. (1998). Team Alignment During Pre-Project Planning of Capital Facilities. CII Publication RR113-12, Austin, Texas, USA.


