POLITECNICO DI TORINO

Masters in Engineering and Management

Thesis title

EVALUATION OF INTEGRATED PROJECT DELIVERY METHOD IMPLEMENTATION IN OPTIMIZING CONSTRUCTION PROJECTS

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1 FOREWORD

I would like to dedicate this effort to my family especially my parents who supported me in all stages of my life and my studies and their continuous support and motivation throughout this journey was the source of power that enabled me to reach here.

I would also like to show my gratitude to Professor De Marco Alberto who supervised me throughout this work and provided me with sufficient instructions, references, and help, also I am grateful to all of the professors who taught me through my master degree where I got the successive series of knowledge that I used to write this thesis about Evaluation of Integrated Project Delivery Method.

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3 CONTRAST

IPD addresses this by synchronizing everyone's goals. The contract increases profit margins for everyone when the owner saves money and decreases them when the owner loses money. The delivery model's system of goal-sharing also encourages everyone to be part of the development, construction, and post-construction table. The whole team wins by using their combined expertise to save time and money while also building a project that surpasses the client's original goals.

The construction industry suffers from many problems like high inefficiency, low productivity, adversarial relationships and contractual disputes between the owner, contractors, architects and, other stakeholders. These factors incur extra costs, schedule overrun and result in poor end quality. All of that degrade the project value from here the need for a new strong model so "integrated project delivery (IPD) model was introduced to upend the often adversarial relationship between the project owner, general contractor, and architect. In most contracts, the financial goals between these parties conflict and what's for the benefit of one stakeholder could hurt the other or add more risk". (Day, 2015)

The approach of IPD model will be discussed in this thesis to build-up a wise evaluation of IPD on the performance of construction industry to know whether to recommend potential adopters to adopt it or not.

4 **BACKGROUND**

IPD was introduced by America Institute of Architecture (AIA) on 2007 The Construction industry declination in the mid-90s was accompanied by a series of problems including constructional projects that were behind schedule and others over-budget, besides a negative and warlike relation between the main parties, Owner, architect, and General contractor, so the Integrated project delivery method was found to solve the problems the construction industry suffered from, IPD incentives all participants to work in a collaborative way to maximize value and minimized wastes for the project, and ultimately all participants were open to share the data directly and to eliminate the barriers the thing that boosted the construction industry .

5 INTRODUCTION

5.1 STATEMENT OF THE PROBLEM:

Integrated Project Delivery mainly based on collaboration and trust, this trust-based collaboration enhances parties to be more focused on project outcomes rather than their own benefits. Without it, IPD will fail and participants will be in an antagonists relationships the thing that will ruin the construction industry today. IPD has a promising outcome, if the participants understand their missions and perform it in a collaborative way.

IPD as defined by American Institute of architecture as " 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 participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction"

Integrated Project Delivery principles can be applied to a variety of contractual arrangements and Integrated Project Delivery teams will usually include members well beyond the basic triad of owner, designer and contractor. At a minimum, though, an integrated project includes tight collaboration between the owner, architect/engineers, and builders ultimately responsible for construction of the project, from early design through project handover

5.2 OBJECTIVES OF THE STUDY:

To investigate how good is IPD model to eliminate the legal, financial, managerial and organizational barriers of a project to optimize the value and whether it really minimize the waste and maximize the value to the owner, in order to give a recommendation to potential adopters whether to use IPD or not, to allow the professional to avoid the considerable cost of applying IPD in case we found out it doesn't worth adopting.

6 LITERATURE REVIEW

Many definitions of project delivery system can be found in the literature review:

The organization or the development of the framework relating the organizations required to Complete or deliver a project and the establishment of the formal (i.e. contractual) and the informal relationships between these organizations " (Halpin D. W., 2006)

IPD has been regarded as a viable solution to the industry's low production and inefficiencies that are still prevalent today (Thomsen, 2010)

Indicated that traditional contracting effects the whole project performance negatively in four major fields:

1. The Absence of sharing ideas during the design phase between trades specialists as each subcontractor do his/her best to secure their position on team.
2. The structure of having individual and meticulously detailed subcontracts with each trade prevents cross-trade cooperation.
3. Coordination between teams is not supported by the contracts, because there are no common benefits each team is working for its own profit.
4. Beneath the outward posturing of teamwork is a basic premise of individual survival because of the contractual structure. (Howell, 2005)

"As the construction industry pursued implementation of Lean practices in the "tools" domain and optimization of the "tone" of a project, it became apparent that traditional contracting methods were inhibitive"

Others defined IPD is a project approach which integrates the three major participants in a project (Owner, Constructors, and Designers) around mutual project outcome.

The key benefit of a building information model is its accurate geometrical representation of the parts of a building in an integrated data environment ((John, 2007)

"The architecture, engineering, and construction (AEC) industry have long sought techniques to decrease project cost, increase productivity and quality, and reduce project delivery time. Building information modeling (BIM) offers the potential to achieve these objectives". (Salman Azhar, 2008).

Multi-party agreement vary in form, as the needs of the project imply it and the main forms are:

- Umbrella agreement: The parties gather together in a single agreement.
- The agreement creates a temporary, virtual or formal, organization complete with management and decision making processes;
- Processes are chosen on correspondence to the team nature;
- Plans and decisions are taken by consensus and seek of the best project outcome.
- **Roles** assigned based on the capabilities of the entities or persons in executing any particular mission.

Robbins, Stephen P., Judge, Timothy A., Essentials of Organizational Behavior, Prentice Hall (11th ed., 2011)

6.1 MULTI-PARTY AGREEMENT:

Multi-party agreement among key participants is a bedrock of achieving IPD goals, those participants execute a single contract to define their roles, duties, obligations, liabilities, rights. As a single agreement is formed each party understand its relationship with the other participants. MPA agreements require trust as overall project success and individual one basically rely on the level of contributions of all participants which means that all members have to work as one team to meet the goals planned.

MPA needs a deep planning, intense team building efforts and careful negotiation, this process occurs during earliest stages of project definition, even it could be costly process but it's crucial and its better if the participants have prior experience with each other.

6.2 TEAM STRUCTURE

The organization of IPD teams varies significantly based on the size and technical details of the project. The size affects the number of teams, their individual scope, and how they will be directed and coordinated. The technical details of the project will determine how organizations are grouped and whether, and how teams are overlapped.

The most effective teams are neither very small (under 4 or 5) nor very large (over a dozen). Very small teams are likely to lack for a diversity of views, and teams of more than 12 have difficulty getting much done. (Robbins, 2011)

6.3 THE ROLE OF TECHNOLOGY IN IPD

Construction projects involve different stakeholders sharing a vast quantity of information. Traditional IT solutions do not provide the necessary collaborative environment to ensure that IPD participants work closely as a team. The need for a collaborative IT solution has been the driver behind the growth of online construction collaboration technology.

Collaboration software streamlines the flow of documentation, communication and workflows; allowing users in different locations to share a common version of documents, drawings, forms and data in one place. Users are able to view and mark up files online without the need for native software. Because of its inbuilt audit trails, the software engenders confidence, minimizes disputes and mitigates risk.

IPD offers numerous benefits to all participants in a construction project. The alignment of the interests and risk/reward of participants with the overall project objectives engenders a spirit of co-operation and team work. It is not surprising, therefore, that this methodology is gaining wider acceptance in the construction industry, and is starting to be applied to projects of various sizes and not only to larger multi-billion dollar projects.

Example of IT technology usage in IPD process in a case study of construction project **"SUTTER MEDICAL CENTER CASTRO VALLEY"**

Immediate, Controlled, and Continuous Access to All Project Information

Given that the key team members were distributed in multiple offices in various states, it became very important from the beginning to design a method for the team to have full and real time access to all project information and models regardless of location.

Portal solutions where models and files are worked on locally and then a copy is uploaded to a shared site so that other team members can download do not promote close collaboration and cross office VPN solutions are not practical.

The team is currently using Project Wise from Bentley Systems, The system manages the references between files and insures that when a team member views or works on a file that they receive the most up to date copies of the file and its references regardless where those files are stored on the network, transferring only the changes made to those files to optimize download times. Currently, there are over 14,000 files and over 21GB of data that is distributed on the various servers and accessible from any location to all team members. (Semdanat, 2010)

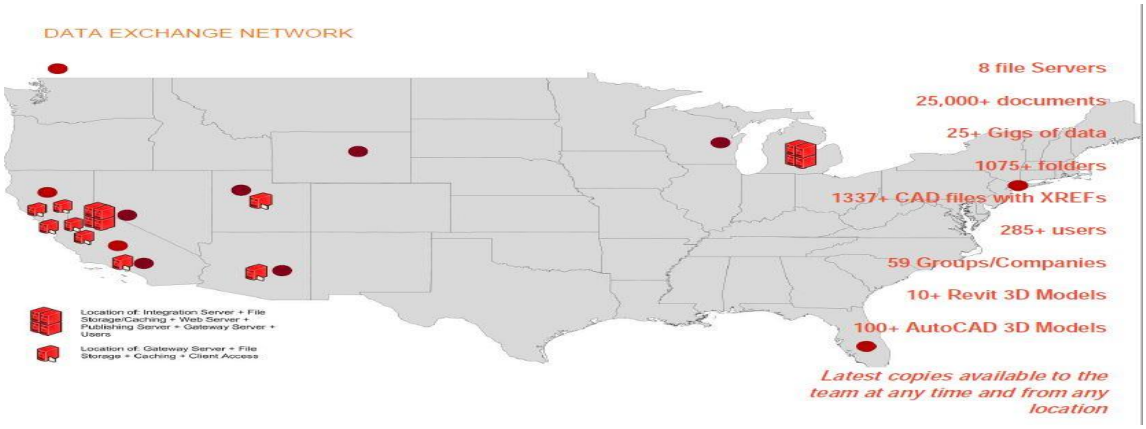


Figure 1 Data Exchange

6.4 IPD ADOPTION STAGES

IPD today

It is true that IPD use is still small, but its growing, but measuring IPD market is difficult, as we have varying approaches and levels mean that the Integrated Project Delivery is used to describe different arrangement and processes. Till now no studies measure that adoption of Pure IPD, even the current financial global problems affected negatively funding of IPD projects, and recession impacted the implementation and adoption of IPD, other in-construction projects was stopped or were changed to cost less.

For owners who saw IPD as a way to gain efficiencies to offset the high costs of the boom market, that wind is no longer in the sails. The cost-basis in some cases has dropped so dramatically that owners are changing procurement models mid-project, and competitively bidding projects previously under negotiated contracts.

IPD tomorrow

Based on our results we noticed that most of the professionals optimistic about the future of IPD but the demand and statistics. Using statistics to forecast the IPD market is difficult and it too much guess which contain a could be misinterpreted or wrong most of the times, we better address the activities that contribute increase the adoption of IPD in the future. In order to increase the adoption of IPD we have focus on creating a need for the IPD by informing and publishing more report and studies about IPD to urge the need for this model, and we should also erase the worries and the ambiguous problems of IPD as the insurance contacts and clarify the conflicting points by issuing more rules and standards by AIA and other construction agencies which concern about IPD.

Figure 2 Factors Driving Increased Adoption of IPD

6.5 THE BENEFITS OF INTEGRATED DELIVERY

- Process design: Creating clear roadmap for the design of the construct team to navigate efficiently the infinite choices suggested throughout the ideation and organization with leads to a creation of the framework of the outstanding design and the collaborative and precise execution leads to absolute success and achieving the goals as the everything is tailored for the mutual benefits of all participants which is the project success.
- Integrated Design: Engaging the broadest range of Creative and design disciplines in an effective and efficient manner from the beginning ensures that the solutions are as rich and content filled as possible. This engagement of behavioral, artistic and engineering perspectives offered at the earliest stages provides the opportunity to discover and explore new building typologies in a timely way.
- Integrated Fabrication: The opportunity to tap the skills and knowledge of the fabricate/construct trades and professionals in optimizing the methods for design realization can make the design tectonics better and more sustainable This approach can also eliminate wasteful duplication of documentation efforts and the errors associated with multiple information transfers.
- Building Information Modeling (BIM): BIM uses 3D digital building models with its parametric information to enable the integration as it enhanced visualization, ease the data sharing and reuse by various members of the building team. BIM is the enabler for integration and open information sharing.

6.6 IPD VERSUS TRADITIONAL DELIVERY

Traditional Project Delivery		Integrated Project Delivery
Fragmented, assembled on just-as-needed" or "minimum necessary" basis, strongly hierarchical, controlled	Teams	An integrated team entity composed of key project stakeholders, assembled early in the process, open, collaborative
Linear, distinct, segregated; knowledge gathered "just-as-needed;" information hoarded; silos of knowledge and expertise	Process	Concurrent and multi-level; early contributions of knowledge and expertise; information openly shared; stakeholder trust and respect
Individually managed, transferred to the greatest extent possible	Risk	Collectively managed, appropriately shared
individually pursued; minimum effort for maximum return; (usually) first-cost based	Compensation/ Reward	Team success tied to project success; value-based
Paper-based, 2 dimensional; analog	Communications/ Technology	Digitally based, virtual; Building Information Modeling (3, 4 and 5 dimensional)
Encourage unilateral effort; allocate and transfer risk; no sharing	Agreements	Encourage, foster, promote and support multi-lateral open sharing and collaboration; risk sharing
Blame, finger pointing, exploiting loopholes, individual reward maximisation, risk averse	Culture	Learning, continual improvement, engaging with reality
Command a control; encourage unilateral effort; Break project into constituent parts; Optimise parts (especially "my bit")	Thinking	Systems thinking; optimise the whole; encourage, foster & support multi-lateral open sharing & collaboration
Top - down: Manage the contract, manage the programme, manage budgets, manage people	Management ethos	Outside- in: act on the system to improve it for customers (helped by those working in it).
Separated from work	Decisions	Integrated with work; based on data
Budget output, activity, standards, productivity	Measures	Related to purpose, capability and variation
Functional specialisation; fragmented, silo based, strongly hierarchical, controlled; constructors not generally added until late in process	Organisation design	Based on demand, value & flow; open, collaborative & integrated team of key players formed at the outset & added to as the stakeholder group grows
Gathered "just - as - needed", hoarded in silos	Knowledge and expertise	Shared openly and early
Contractual	Attitude to customers	What matters to them? Understanding their human and Technical concerns.

Table 1 Comparison between Traditional and Integrated delivery

Many of conducted research about project delivery systems have found that the more collaborative delivery systems outperformed the less collaborative Project delivery systems and we could mention some researches performed by (Konchar and Sanvido 1998; Kulkarni et al. 2012; Pocock et al. 1996; Rosner et al. 2009; Songer and Molenaar 1997; Thomas et al. 2002), but not so many research really aimed to proof that suggestion based on that in the next topic we will discuss some.

6.7 BUILDING INFORMATIONAL MODELING (BIM):

We should understand that IPD and BIM are two separate subjects: IPD is the most modern update of the project delivery and BIM is the latest advancement in model-based technology.

IPD can perform without using BIM and BIM can be used in projects that don't use IPD as a delivery method

However, the greatest benefits are realized when the IPD method is used for project delivery with BIM being used as a design and construction tool.

Building information modeling is considered the most bright development in many Fields (Architectural, engineering and constructional), beside this technology enabled us to virtually model a digitally constructed building with an accurate dimensions and details such technology mainly used to plan, design, construct and operate, as it helps the all main contractors (Architects, engineers…) to visualize a stimulated environment for the structure of any potential design and detecting operational and constructional issues before happening. BIM enhances the integration of stakeholders.

➔Why do BIM and IPD go hand in hand?

BIM and IPD complement each other by improving the management of the project through increased data exchange and cooperation between stakeholders, which results in:

(a) Less risk of defects and rectification;
(b) Less waste of materials; and
(c) Less issues during construction.

IPD is the catalyst which allows the parties to easily share ideas, information and intellectual property and this coupled with BIM, creates efficiencies throughout the life of the project. This methodology also removes the "us vs them" mentality because parties must share otherwise protected intellectual property to achieve the project outcomes.

In USA and UK, BIM is spreading widely and implemented

The American Institute of Architects advocates the use of IPD/BIM as an innovative delivery model. Although the uptake was slow at first, it is gaining momentum especially given the use of IPD/BIM on a number of health infrastructure projects. An example is the Sutter Health Fairfield Medical Project, which was one of the first high profile projects incorporating IPD and BIM while in UK, a Fully Collaboratively 3D BIM was mandated by UK government (with all project and asset information, documentation and data being electronic) on all UK Government construction projects by 2016.

While approximately two-thirds of the respondents to the Pinsent Masons' survey think this timeframe will not be met the fact that the government is mandating the adoption of collaborative 3D BIM necessarily will involve increased adoption.

BIM RISKS

- LEGAL RISKS

Contractual risks related to the responsibility of controlling the entry of data and in case of any inaccuracy that will take this burden, especially that there is a frequent update in any BIM data and ensuring its accuracy is accompanied by a great risk.

Lack of determination of ownership of the BIM data and the need to protect it by legal channels or through copyright laws. To prevent a disagreement over copyright issues, the best solution is to set forth in the contract documents ownership rights, which aims to avoid discouragement of participants from fully realizing the model's potentials and responsibilities.

When project team members other than the owner and architect/engineer contribute data that are integrated into the building information model, licensing issues can arise. For example, equipment and material vendors offer designs associated with their products for the convenience of the lead designer in hopes of inducing the designer to specify the vendor's equipment. While this practice might be good for business, licensing issues can arise if the designs were not produced by a designer licensed in the location of the project. (Thompson, 2007)

- BIM FUTURE CHALLENGES

Inputting and reviewing BIM data requires a huge deal of responsibilities that nobody want to carry, beside that it's a time consuming activity and incur cost which can be offset by the dramatic increase of the efficiency and schedule gains (saving time) thing which made requesting for complicated indemnities by BIM and offering limited warranties are the bases of any negotiations points to be resolved prior the use of BIM technology

6.8 BIM CASE STUDY

Stanford University's Center reported after gathering data and studying 32 major projects and reported as conclusion benefits of BIM:

- Up to 40% elimination of unplanned expenses
- Cost estimation accuracy increased by 3%.
- Up to 80% less time needed to prepare the cost estimate.
- 10% save in contract value by detecting clashes.
- Up to 7% reduction in project time.

6.9 AGILE SCRUM METHODOLOGY & LEAN CONSTRUCTION

"Lean is an approach that identifies the value inherent in specific products, identifies the value stream for each product, supports the flow of value, lets the customer pull value from the producer, and pursues perfection" (Karkukly, 2013)

“Lean is doing more with less. Use the least amount of effort, energy, equipment, time, facility space, materials, and capital – while giving customers exactly what they want” (Womack J.P, 2008)

Agility is the ability to both create and respond to change in order to profit in a turbulent business environment. Agility is the ability to balance flexibility and stability. (Highsmith J, 2002)
‘Lean’ and ‘agile’ are two separate approaches to management, some researchers linked between the two as they have some of the common features but as they developed in parallel path sometimes they are considered the same.
Both of these approaches have the same final goal but they are distinct but at the level of construction project they are the same.

Figure 3 Construction projects overruns

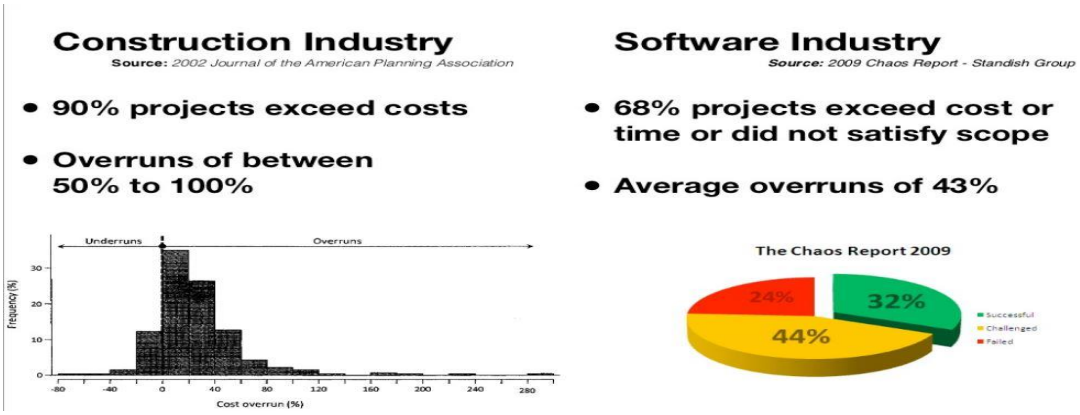


Figure 4 Cost overruns in construction industry

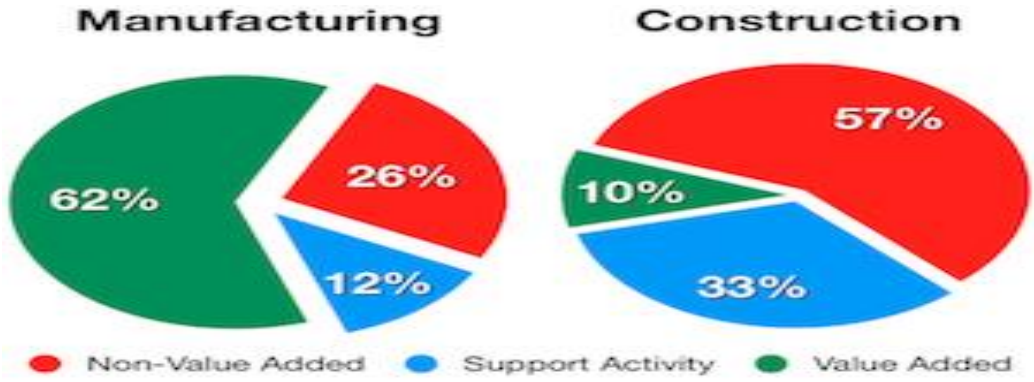


Figure 5 Construction Productivity

Causes of Construction overrun:

1. Poor documentation and design
2. Delays in decision making or instructions
3. Poor communication and information dissemination
4. Client scope change during construction
5. Mistakes in construction
6. Poor labor skills, availability or disputes
7. Incorrect material types or quantity
8. Weather

6.9.1 LEAN & CONSTRUCTION

Lean originated as an approach to improving manufacturing systems by focusing on **creating value and eliminating wastes,** lean has become now a way of thinking and a set of practices that can be applied to almost any work process. Lean construction is an adaption of the lean principles and practices to the design and execution of construction project, it provided the traditional construction with management approaches as:

- Maximizing value generation
- Information flow and creating materials, using plan execute and control paradigms

Lean IPD was founded in 2016 with the goal of sharing information and best practices in order to further the use of Lean Construction, Integrated Project Delivery and Building Information Modeling to ultimately improve outcomes in Design and Construction of capital projects.

Figure 6 Lean principles

1.The waste of Overproduction Symptoms of this waste are: •Just in case manufacture or supply working ahead of need •Excessive lead times (take long time to produce) •Excessive storage •Excessive work in progress (labor/machine)	**2. The waste of waiting** Symptoms of this waste are: •Ineffective use of time •Lack of motion •Lumpy flow (e.g. material) •Opportunity cost of waiting time	**3.The waste of unnecessary transportation** Key observations: •Better communication can lead to less transportation •People, plants and processes should, where possible, be linked •The number of steps in a process should be minimized
4. The waste of inappropriate processing Key ideas: •Processes need to be both efficient an effective •Focus on process and not product •Avoid expensive, often "high tech" investments over specified in relation to the real need •Ensure quality capability at all stages •Avoid double handling	**5. The waste of unnecessary Inventory** Negative aspects of inventory include: •Inventory generates ownership cost •Inventory generates opportunity cost •Inventory impairs(do harm) flexibility	**6. The waste of Unnecessary Motion** Be concerned with ergonomics, and avoid such activities as:- •Stooping •Bending •Lifting •Reaching •Over-exertion(need more energy to perform)

Table 2 Wastes that Lean works on

LEANNESS	AGILITY
Developing a **value stream** to eliminate all **waste,** including time, and to enable level schedule	Using market **knowledge** and a virtual corporation to exploit **profitable** opportunities in a volatile marketplace

Table 3 Difference between LEAN AND AGILE

Advantages of Lean approach	Disadvantages
• Reduced waste • Quicker response to customers' demands • Shorter throughout time • Lower supervision costs • Lower stock levels • Improved quality	• Increases in workers' responsibilities can lead to pressure and anxiety nor present. • Expansion of job requirements without comparable increases in pay • The company is the main beneficiary of employee-generated improvements • Possibility of staffs redundancy

Table 4 Advantages and Disadvantages of Lean approach

6.9.2 AGILE & CONSTRUCTION

Agile is the set of the value and principles it's a collection of beliefs that teams can use for making decisions about how to do the work of developing software

Classical methods of software development methodologies like Waterfall Model, Iterative models, have many disadvantages:

- Huge effort during the planning phase
- Poor requirements conversion in a rapidly changing environment
- Treatment of staff as a factor of production

From here we start looking for new methodology *Agile Software Development Methodology*

6.9.3 APPLICATIONS OF BUILDING INFORMATION MODELING

The different uses of IPD:

- Visualization: 3D virtual detailed constructing with the ability to roam inside.
- Fabrication/shop drawings: It is easy to generate shop drawings for various building systems.
- Code taking into account: Fire departments and other officials may use these models for their review of building projects.
- Cost estimating: BIM software is provided with a cost-estimation option which is self-adjusted in case of any changes happened in the model or in the prices of materials used which is extracted automatically from the market.

- Minor benefits:
  - Faster and more effective processes: Information shared between the participants in an easier way the thing that can add value to the project.
  - BIM enabled us to analyze accurately the building proposals; simulations performed quickly, performance benchmarked, enabling improved and innovative solutions.
  - Improved customer service: illustrating visually for customers for a better understanding of the proposals.
  - Lifecycle data: Requirements, design, construction, and operational information can be used in facilities management

6.10 **WASTES**

The ultimate goal of IPD is to reduce the wastes to increase the value of the project.

As the pie chart below shows the biggest slice is for the labor waste Define waste as “any human activity which absorbs resources but creates no value.” The negative effects of mistakes and rework are amplified considering the inherently wasteful nature of construction labor itself. (Jones, 2003)

As asserted that labor is the largest cost component of a construction project accounting for 40-60% of total cost and found only 42% of labor to be value added to the project. (Hanna, 2010)

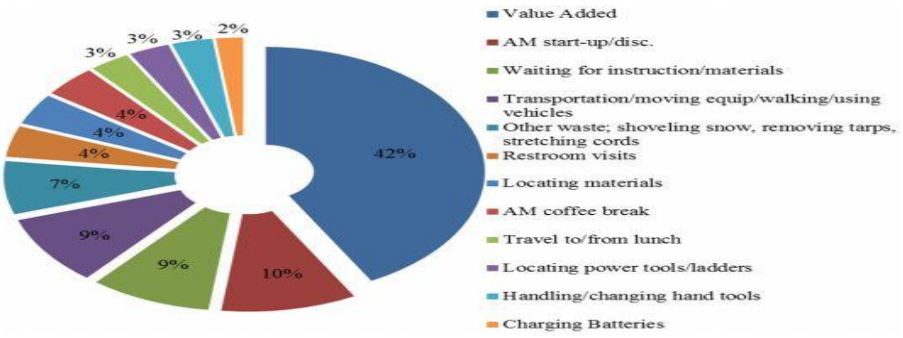


Figure 7 Waste portions

6.11 CONCERNS WITH INTEGRATED PROJECT DELIVERY

IPD as every method even though it has great features, it also has some issues.

These issues must be taken into consideration before implementing IPD as Construction delivery method.
The most 3 significant concerns are:

1. Contracts
2. Insurance
3. IPD facilitator

A chapter is devoted to discuss these concerns with the suggested solution.

IPD can't use the construction contracts applied in traditional methods. The Contractual relationship, Compensation and insurance are the three largest elements that require change to accommodate IPD.

Contractual relationships are much different in IPD than other traditional delivery methods. Instead of parties entering to the project at different times at IPD contracts take into consideration involvement of all parties from the beginning and everything is a group effort this contractual relationship is not applicable at the level of IPD because it's not setup to the handle with teamwork.

Traditionally each party manages themselves to minimize their own risks increasing the separation of the parties, and minimizing integration and collaboration in design, while Contractual relationships that bind 2 or more parties are tied together in a contract that is the bedrock of IPD.

Being that IPD is a new delivery method and completely different from what was done in the past, there are no prior contracts to follow in the drafting of the IPD contract

To assist in resolving this issue "the AIA is currently developing standard forms to assist parties wishing to negotiate and execute an IPD agreement" (The American Institute of Architects & AIA California Council, 2007, p. 17). These forms are currently known as transitional agreements to help assist in the transition from a traditional contract to a totally integrated contract.

7 CASE STUDIES

IPD Performance Studies
Recognizing the lack of research that existed on the use of IPD in the construction industry

(Becerik-Gerber, 2010) Launched a study to investigate the current status of IPD adoption and the industry's knowledge and experience with IPD.

The number of participants was 415 participants

1. IPD was reported to reduce change orders and save cost by 70.3% of respondents
2. Fewer requests for information (RFIs) (58.6%)
3. IPD have shorter schedules by 69.4% of respondents
4. Less construction administration (36%)
5. Fewer injuries (21.6%)
6. Improved quality, less friction, and more enjoyable projects were also reported.

Their research, although very intriguing and important, only gathered qualitative responses regarding individuals' beliefs and thoughts about IPD. It was not aimed at comparing specific performance measures between projects in order to draw conclusions based on quantitative analysis.

7.1 PROJECT QUARTERBACK RATING PQR

It would be nearly impossible to develop a widely accepted model to evaluate the performance of integrated project delivery that includes all factors that affect performance. So we resort to a cumulative methodology of evaluating project performance Project Quarterback Rating (PQR) is an approach to accurately measure overall project performance taking into consideration only the most significant factors affecting success.

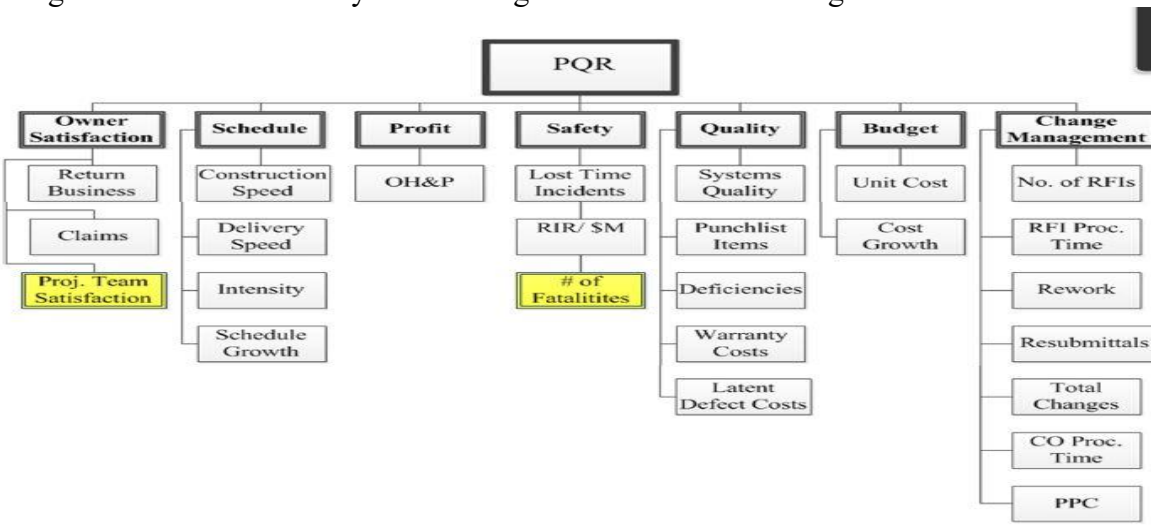


Figure 8 Project Quarterback Rating model

7.2 CASE STUDIES ANALYSIS:

Besides the questionnaire that will be conducted in this thesis we will analyze some case studies of some projects performed using IPD and the selection of those projects was not arbitrary but it was based on the successfulness of the project, numerical records that enable us to compare it and to measure to which extent is using IPD has a positive impact on meeting project goals, with least wastes possible.

Applying for IPD benefits

- Accelerated schedule and aggressive cost target
- 30% lighter than conventional project
- 10 stakeholders entered into a multi-party contract and 25 firms were expanded project team
- Accomplished in 8 months rather than the expected 18 months
- No cost increase thanks to the collaboration and integrated approach

Applying for BIM benefits

- More accurate quantity take-offs
- Eliminating 34 redundancies
- Improving communication
- High quality structural steel design

We have listed 3 Case studies each has different results as IPD will have a different outcome as the project varies, its goal and participants.

1. Cathedral Hill Hospital
2. MERCY Master Plan Remodel
3. Lawrence & Schiller Remodel

- **Sutter Medical Center Castro Valley**

After reviewing this project that was conducted using IPD, which proved afterward to be the best possible approach to successfully, execute the project.

The benefits of choosing IPD as a delivery method were too many compared to what traditional delivery could fulfill.

We have listed 12 Case studies each has different results as IPD will have a different outcome as the project varies, its goal and participants.

- **The Cathedral Hill Hospital project**

after the significant delay before the construction due to external factors, IPD model permits the project team to adjust productivity while avoiding the extra potential cost. Beside the owner was rewarded a remarkable financial benefits during the design phase estimated to be 400% return in invest beyond traditional design method, by involving the stakeholder early and overall project focus.

The MERCY Master Plan Remodel: This case study shows how IPD may not achieve to decrease cost or schedule, but in prevention of increases each, and improved control and predictability. It also

shows the IPD cost superiority and controlling and managing the complex projects with frequent occurring unforeseen conditions.

Beside the above 3 case studies summary we will display a case study report which included 59 companies, 48 of them in US, 9 in Canada, 2 outside of North American conducted by UNIVERSITY OF MINNESOTA under the title of " IPD: Performance, Expectation and future use." The projects have a different scopes with different complexities and types.

The Respondents were asked to rate their impressions of the performance of their projects compared to what they have experienced on non-IPD projects.

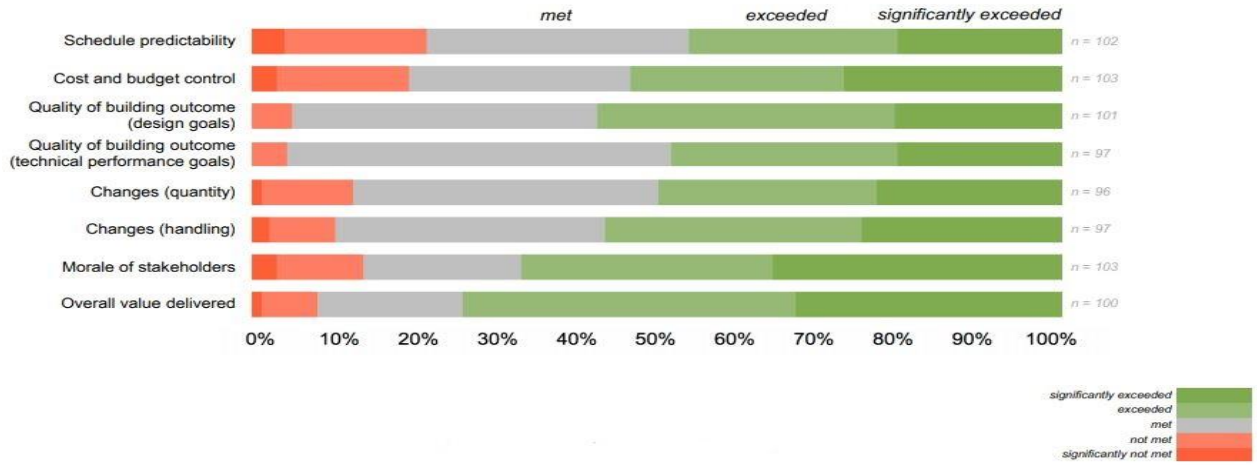


Figure 9 Summary of case studies

7.3 **MULTI-PARTY AGREEMENT**:

Multi-party agreement among key participants is essential to achieving IPD goals, those participants execute a single contract to define their roles, duties, obligations, liabilities, rights. As a single agreement is formed each party understands its relationship with the other participants. MPA agreements require trust as overall project success and individual one basically rely on the level of contributions of all participants which means that all members have to work as one team to meet the goals planned.

MPA needs a deep planning, intense team building efforts and careful negotiation this process occurs during earliest stages of project definition even it could be the costly process but it's crucial and its better if the participants have prior experience with each other.

Multi-party agreement vary in form, as the needs of the project imply it and the main forms are:

- Umbrella agreement: The parties gather together in a single agreement.
- The agreement creates a temporary, virtual or formal, organization complete with management and decision making processes;
- Processes are chosen on correspondence to the team nature ;
- Plans and decisions are taken by consensus and seek of the best project outcome.
- Roles assigned based on the capabilities of the entities or persons in executing any particular mission.

There are three multiparty contracts that have been successful for IPD projects according to those individuals interviewed. The three contract forms are: ***AIA C191-2009, ConsensusDOCS 300, and Sutter Health's*** Integrated Form of Agreement/Integrated Project Delivery Agreement (IFOA/IPDA).

7.4 WHY DO WE NEED IPD

According to statistics done in the US, which took a sample of taking the construction projects in the US, we get these results:

1. 30% of projects do not make schedule or budget
2. 92% of project owners say architects' drawings are insufficient
3. 37% of all construction material is waste
4. 72% of U.S energy use is from buildings
5. $15.8 Billion cost due to lack of operability
   (Architect may design Autodesk program which is not used contract may not be using this program the time taken to match these groups is lost in time)
6. The productivity of Construction industry declined while it noticeably increased in other industries, from here the need for innovation for revolution was realized.

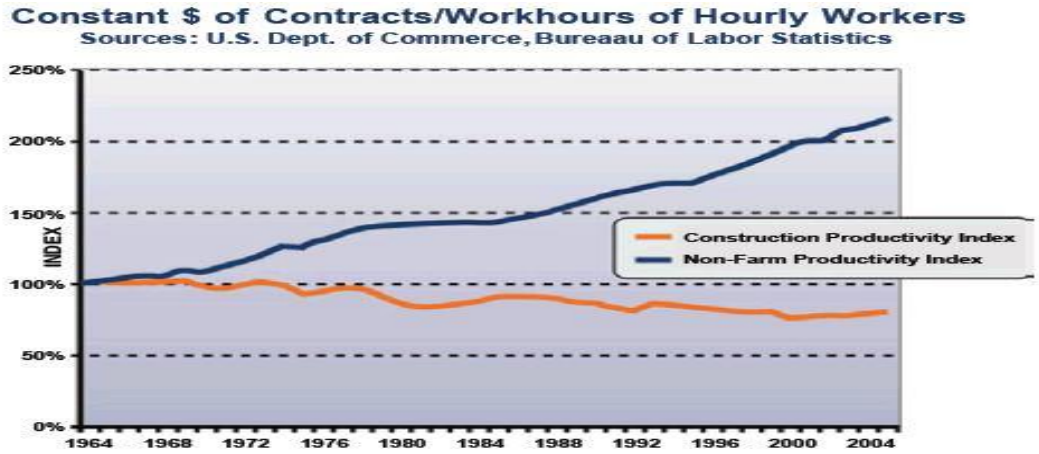


Figure 10 Constant $ of Contracts /Work hours of Hourly Workers

These inefficiencies were claimed to be caused by:

1. The division between the design and the construction industries.
2. Difficulties communication between the contractors and the architects
   Redundancy (architect's drawing have to be redrawn)
3. Cost plus contracts are paid not necessarily to be efficient but to do as much work as they can do as they are paid the cost plus time and materials and fees.

The solution of all of those problems can be summarized in 3 letter IPD as it works on:

a. Cost: efficiencies in design, contingencies are for the project not for the various team members of the project, agreement not to sue, so the risk premium that will be added on the top of the fee is no longer there.
b. Speed: IPD is generally fast-track, Autodesk project can be done in 10 months.

c. Responsive and flexible: Owner is participating in the team if there is a question that come up, also architect and contractor to answer the question and to respond to each other and there is not 14 days Request For Information RFI.

d. Sustainability: (People, Planet and Profit facilitated by IPD when you think about environmental (37% of all construction material is waste) while using BIM,
   i) Economic (Contingency is for the project success as everyone of the team is incentivized to build the project as efficiently and cost-effectively as possible because the cost saving comes back to the team members)
   ii) Social elements: involvement of the key participants very early for decision making, design, determining the budget and the schedule, so they actually have an investment in the success of the project that means they have a social personal investment.
   we have to think about suitability not only for its incentives but also there are mandates to build sustainably, Moreover building codes are moving in more sustainable direction which requires integration and collaboration of the key participants of the project.

7.5 GENERAL DATASET CHARACTERISTICS

Before making the questionnaire analyses and draw the statistical analysis is important to understand the characteristics of the small sample of IPD projects compared to the other types of vertical construction project after choosing arbitrary 32 construction projects in the US, therefore drawing a general conclusion about the small population is even more difficult and less precise.

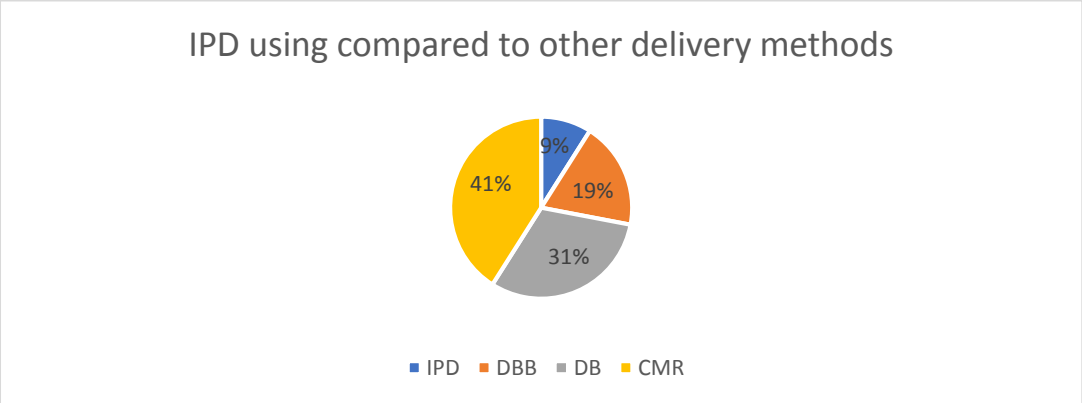


Figure 11 Used delivery methods percentages

Till today IPD is not fully understood throughout AEC community. Based on a recent study conducted by AIA. Although 84% of members aware of IPD, 40% understand IPD and 13% implement IPD and use it actually.

(Architects, 2011)

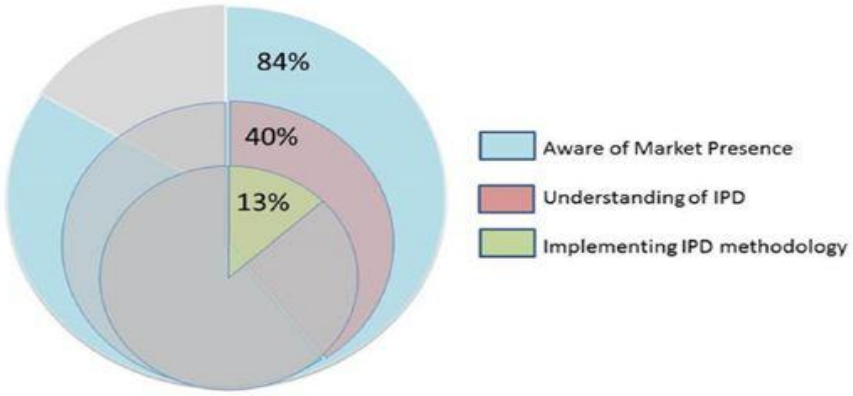


Figure 12 AIA Member Awareness of Integrated Project Delivery

Research motivation

- Many mega structures were performed using IPD , the construction companies have different opinions about IPD , some embraced it and find it so beneficial while others have different opinion , and always there are somebody who could be willing to embrace it but lost in the mid of the two different opinions , based on that in this thesis a questionnaire will be conducted and based on the results of this questionnaire the given data will be analyzed to draw a final conclusion that will answer the main question of the potential adopters of IPD.

- In order for IPD to be widely adopted by the construction industry research needs to be done to provide satisfactory evidence that it will improve profits, save money, and reduce operating costs (BECERIK-GERBER, Augest 2010) or provide other tangible benefits that will promote its widespread utilization. The void of IPD research combined with the wide-spread interest of IPD provides an ideal opportunity to make significant contributions to the body of knowledge within the AEC community with respect to IPD

7.6 OUTLINE OF RESEARCH METHODOLOGY

The methodology consists of six steps described below. The six steps are as follows:

- Definition of scope and objectives
- Review literature
- Develop questionnaire
- Identify target population (convenience sample)
- Collect and analyze data
- Propose conclusions and recommendations

IPD adaptation pace is increasing but the more convincing and satisfactory evidences of the ability of IPD to improve profit, save money and reduce wastes and cost beside feedbacks of experts, professionals in the construction industry and taking into consideration the tangible benefits all will urge new adopters to adopt IPD.

7.7 RESEARCH METHODOLOGY

A two-phase approach was taken to conduct the research as shown in.

Phase 1: consisted of a literature review and data collection through publishing a Questionnaire targeting professionals and researchers who have experienced IPD before by researching about it or implementing it

Phase 2: Analysis of the data obtained from the professionals who already experienced IPD the thing that will enable us to evaluate IPD beside the background of the case studies discussed before in brief

7.8 MOTIVATION TO CONDUCT RESEARCH:

This research handle with many metrics to evaluate IPD, through readings literature reviews about IPD and also I have come across many case studies and research papers which took into consideration only very few metrics in studying IPD, based from my believe that the more accurate studying, measuring, evaluation of IPD should take into consideration as much as metrics all together at the same time, especially we can't assess IPD model by looking only at one side the process.

Also, this research discusses the issue of adoption of IPD, which is important to understand how the future of IPD model will look like apparently based on beliefs of the professionals and researchers who took the survey.

To do that we've have investigated:

- Reasons for not adopting IPD
- Issues that deter adopting IPD
- Future expectations of IPD adoption.

7.9 DATA COLLECTION

Google form has been created and it is published to easier the transformation of the questionnaire and to make it easy to deliver and fill it in 3 min, as the long questionnaires usually deter the potential professional from filling it. Contact via email and/or phone calls was attempted to some industry professionals representing some different construction companies, which use IPD in its project at least once, also researchers will be communicated if possible, at the end we will collect all the responses and analyze them based on how expert is the person who filled it

7.10 DISTRIBUTION

Actually data collection was conducted via emails, invitations from google and/or phone calls was attempted to several big construction companies and we reached those construction companies representatives and professionals by searching them online and through the case-studies reports about IPD projects, besides that we asked professors in Civil, Architecture, Management departments and a good range of potential respondents were found as they had a research papers about IPD, which we benefited from to write this thesis.

Other application was used to distribute this questionnaire, as we knew already usually there is a low response rate usually. (LinkedIn, Facebook, Google+, Twitter at the end of we have

sent 2450 invitations and we were able to gather 219 response, I will keep this the questionnaire open to be able to trace how IPD and opinion about IPD will change in future.

7.11 QUESTIONNAIRE:

This Questionnaire aims to evaluate Integrated Project Delivery and to investigate the adoption of IPD and to evaluate its efficiency in optimizing construction planning.
This questionnaire will address mainly the professional who experienced using IPD.

1. Do you use Integrated Project Delivery?
2. How long have you been using IPD?
3. Integrated Project Delivery projects have shorter schedule than other delivery systems
4. Using IPD is less effective for small projects.
5. Using any of traditional delivery method could give better outcomes than using IPD
6. IPD usage decreases the number of modifications in the project.
7. Using IPD is efficiently used in achieving cost saving.
8. Unfamiliarity of participants who are using IPD in a project leads to failure of the project.
9. How broadly do you integrate your project delivery?
10. Using IPD maximizes the Profit of the project.
11. Using IPD improves the quality of the project.
12. IPD has a promising future and the number of adopters is increasing
13. Improving building Industry results through using both Integrated Project Delivery and Building Information Modeling together.

7.12 ABOUT THE QUESTIONNAIRE LAYOUT:

I. Respondents:

We are going to categorize the respondents to **3 types:**

1. The respondents who never heard about IPD.
2. The respondents who have experience IPD method by implementing it. And it based on, the number of IPD projects has implemented, we will classify him as an expert respondent or not.
3. The 3rd category is the respondent who has studied IPD methodology and analyzed case studies for actual IPD projects.

➔Based on the respondent's category the questionnaire path and questions could be different as this questionnaire is designed to be tailored to differentiate between the types of the respondents.

II. Responses of each respondent:

1. This questionnaire is designed to terminate and submit if the respondent doesn't have an idea about IPD to have more accurate results.
2. Those who have heard about IPD before but they haven't practiced it at all will be asked which delivery method have they used before, to know which method is the most used and the reason behind not adopting IPD yet.

3. The 3rd category of the respondents have heard, practiced or studies IPD as methodology or IPD case studies they will be able to fill the whole questionnaire and based on their response we will develop a complete analysis to figure out and get the final result of our questionnaire.

III. Developing questionnaire

The questions asked were developed from the literature review, the issues of IPD that were elaborated earlier, in order to measure and to evaluate IPD we should've used specific metrics to measure the efficiency in optimizing construction and improving the productivity of construction projects.

IV. Metrics

In construction-related literature, several KPIs have been introduced to cover team performance, communication, stakeholder, and human-resource management"

- Cost saving
- Improved Quality
- Productivity
- Number of adjustments/modifications
- Reduce Waste
- Collaborativeness
- Goal-sharing

This questionnaire also investigate some issues and some common beliefs of IPD:

1. IPD model should be reserved only for big complex projects
2. IPD model outperform the traditional model
3. BIM and IPD go hand in hand in tool optimize productivity and efficiency of the project
4. IPD upends the often adversarial relationship between stakeholders
5. Complexity of IPD insurance contracts deters adopters from adopting IPD model.
6. Factors that add value to the IPD project.
7. Contractual issues faced

Keywords: IPD AND BIM, size of the company, project complexity, Issues, value, Contractual difficulties.

7.12.1 QUESTIONS TYPES:

1. **Category type questions**
2. **Ordinal questions**
3. **Continuous questions**

- Used SCALE
- A LIKERT scale is commonly used to measure knowledge, perceptions, values, and behavioral changes. A Likert-type scale includes a series of statements that potential respondents may choose from in order to rate their responses to evaluative questions.
- We used a **LIKERT scale tool** to get the answer to which extent the respondents agree on the arguments that we are investigating, and the other **checkbox tool** helped us to be more specific to know which reason(s) standing behind slow adoption, adding value factors and benefit of implementing IPD.
- Multiple choice questions used to gather information about the respondents to be able to classify them to draw out the analysis based mainly on experts responses.
- The benefit of the type of questions and tools is to make it easier for the respondent to fill in the questionnaire, **take much less time** than typing the answers and consequently that **incentivize respondents to respond** as it will take short time around 10 min to complete the questionnaire, also it helps in recording data automatically without resorting to traditional way of gathering data that is usually time consuming and less accurate.

LIKERT SCALE STRENGTHS:

1) Simple to build
2) More likely to come out with highly reliable scale
3) Easy to read and complete for participants

- Targeted Information**:**

After the introduction about the questionnaire, which elaborates the goals of the questionnaire, the importance of this research and categorizes of the respondents. It is time to summarize the type of information that we are questioning.

1. Questions for only the expert respondents about the efficiency and performance, and issues of IPD in the construction projects that they have experience taking into consideration the metrics of evaluating the performance is(Quality, schedule, productivity, goal-sharing, Cost saving, number of adjustments and collaborativeness)

2. Also, we look about how important is using BIM tool when implementing Integrated Project delivery.

3. Also, the questionnaire investigates the most common contractual difficulties that are faced by the professionals who are implementing IPD.

- Can using BIM tool optimize the outcome of IPD model in construction project (Quality, value, plan, schedule) or not.

- Whether IPD model is more efficient in large companies and complicated projects rather than the small-sized companies and simple projects.
- Small-sized companies and simple projects as its controversial point between different case studies.
- IPD ends the often adversarial relationship between stakeholders by setting one goal for them all and whether that if the actual life scenario.
- Unfamiliarity of participants fails the project.
- Implementing IPD methodology can improve the construction and design quality of the project, and can reduce waste.
- Implementing IPD methodology at construction projects can reduce wastes and squeeze out the biggest profit.

8 DATA ANALYSIS

8.1 QUESTIONNAIRE SUMMARY:

The survey questions were divided into 5 parts:

1. Question to gather data about the respondents
2. To test out hypothesizes about IPD relation with BIM, size of the project, superiority over Traditional delivery methods
3. To investigate the contractual difficulties of IPD
4. Evaluate IPD by using the metrics of (short schedule, Reduce wastes, Improve quality, and decrease modifications.
5. Forecasting the adoption future of IPD through analyzing collected data:

For the first question we asked questions to categorize the respondent based on:

Informed, Experienced, Country, Stakeholder role, Years of experience in construction, Number of IPD project participated in, size of the projects,

1. About the respondents

- **Respondent's roles**:

Considered in this analysis are the following each consisting of at least 10% of the total survey respondents: Engineers (35.2%), Project Managers (21.9%), Researchers (12.3%), Construction Managers (11.4%) and General contractors (10%).

The next disciplines consisted of 5% or less the total survey respondents Architects (5%), Owner (2.7%), Professors (0.5%). Based on the detailed personal information provided respondents were categorized into the following profile groups: Executives (40.64%), senior management (46.1%), Junior staff (13.2%).More than one-thirds of the respondents were in top management and more than half of them were executive. This could be due to the top management's and executive's interest in the topic as well as the nature of questions in the survey. 42% of the respondents were based in the United States and a major parts were from UK (15%), Australia (8%) Canada, Sweden and other 16 countries from different continents and specially Europe.

In the following sections, IPD experience and awareness among respondents is analyzed, characteristics of IPD projects are identified, and issues around IPD are discussed. Since owners have the most say on whether IPD projects are adopted, the perception of this particular group is singled out and highlighted when appropriate.

- ***IPD Experience and Awareness***

Overall, 34% of total respondents have experienced IPD. The rest of respondents (66%) are inexperienced, saying they have not been involved with an IPD project. 43% of those respondents are both inexperienced, and not informed about IPD while 57% of all respondents are informed but haven't experienced IPD before and that is a problem we also will investigate the reasons of not adopting IPD in this thesis.

No further analysis of this group is conducted in this paper. The results show that the good portion of the respondents either do have a direct IPD experience or familiar with IPD concepts and minority of them never heard about it and never implemented it, if I would compare this result with a similar survey in 2010 (David C. Kent, 2010) ,were only 30.6% of the respondents were informed about IPD the I would say the awareness about IPD has significantly increase and the implementation of IPD is increasing as before the majority of them had no idea about IPD and never used it. This is an important finding which shows the need for professional and education on this topic as more than one-third of the respondents who never used IPD have no idea about it.

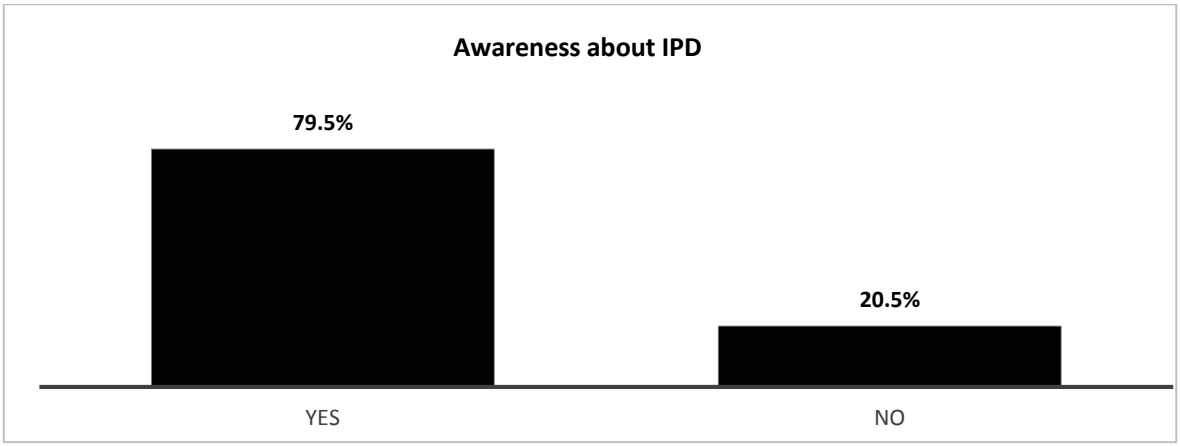


Figure 13 Respondents awareness

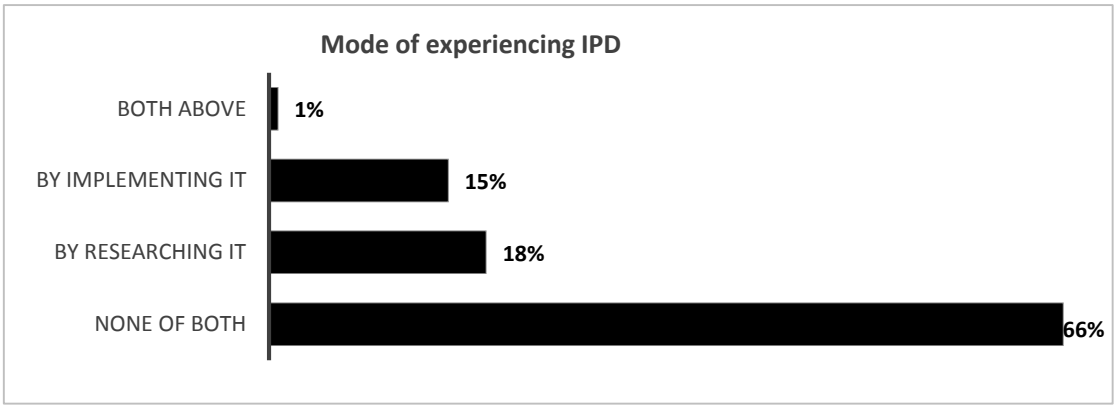


Figure 14 Experiencing IPD

Experienced	43%
Not experienced	57%
Informed	79.5%
Not informed	20.5
Experienced and Informed	42%
Not Experienced and Informed	58%

Table 5 Respondents categorties

It was significant to notice that that a good deal of the informed respondents are have not experienced IPD 58%.

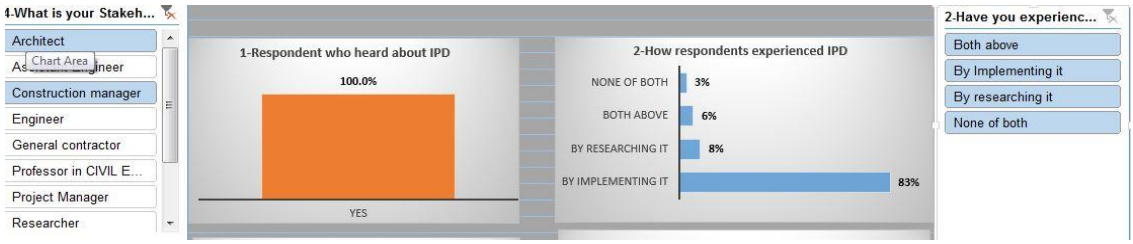
Spearman Rho: Informed, Experienced

Correlations Spearman rho	0.465
P-value	0.000

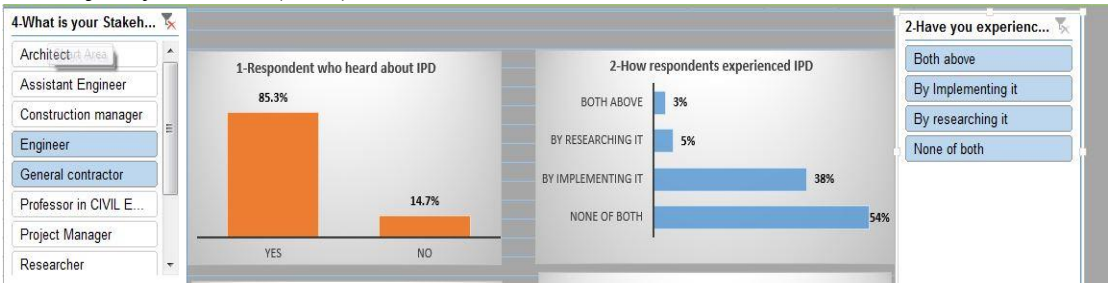
The correlation test showed that they have a positive strong relation as the coefficient is +0.465 also the P-value is less than 1% so it's a significant relation. Relation between the stakeholder roles of the respondent.

The following analysis demonstrates how responses from the experienced and informed groups vary based on respondents 'occupation, the size and revenue of their firms, and their experience with other project delivery methods

Architects and Construction managers are the most informed and most experienced about

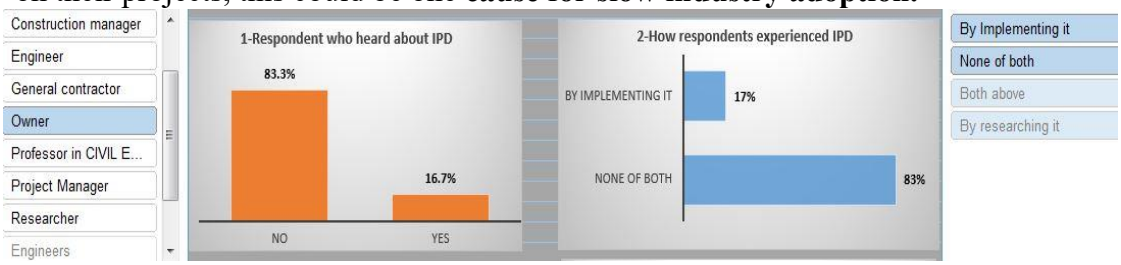


IPD While less than half (54%) of Engineers and general contractors have never used IPD but the majority of them (82%) have heard about it.



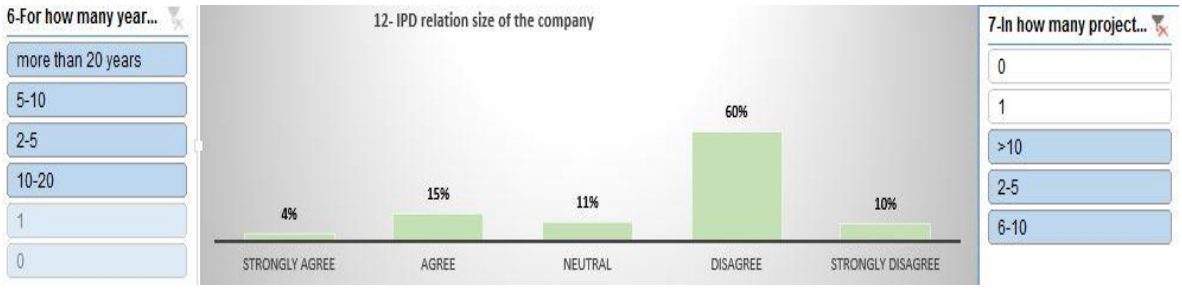
- Around 65% of the project managers have experienced IPD by implementing it and 62% of the researchers have experienced IPD by researching it through analyzing case studies about IPD.
  As a conclusion Engineers (56%), Researchers (38%) and General contractors (36%) are implementing IPD the less compared to other respondents.

- We should point out that owners seem to be the least experienced and informed about IPD. Since this group tends to have the most influence on the type of delivery method to be used on their projects, this could be one **cause for slow industry adoption.**



8.2 **PROJECTS: (EXPERT USERS)**

Experienced respondents were polled to get their opinions regarding project types and sizes that they believe would work well with IPD by asking them to which extent do they agree (*IPD method should be reserved only for large, complex projects rather than small, simple projects*.) and the results shown in the pie-chart below



After we filter to get the answers of the experts in IPD as they should have an experience in construction industry more than 2 years and they have participated in execution of at least two IPD projects for all stakeholders.
The majority disagree which means they don't believe that IPD should only be used for large and complicated projects.

Keeping the same setting for the expert users however when adding the filter of size of the company the respondents work for it shows that

Size	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Sum disagree
Large	2%	10%	14%	59%	14%	73%
Mid-sized	8%	21%	8%	62%	3%	65
Small	0	25%	0	50%	25%	75%

Table 6 size project

So as noticed the respondents were not biased and the large-sized companies and the small companies rejected the idea that IPD should be used exclusively for Large and complex projects.

Respondent	Small	Mid-sized	Large
Not informed	69.23%>	26.92%>	3.85%
Informed& No experienced	36.21%>	32.76%>	31.03%
Informed& experienced	22.96%	<37.04%	<40.00%

Table 7 Size of IPD project

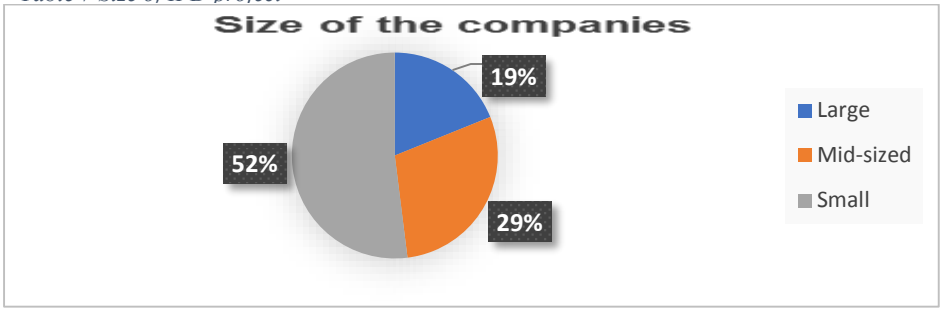


Figure 15 Size of IPD project

We could comment the table as the more experienced the respondent the bigger the size of his organization which the respondent belong to, the higher the probability to be Experienced, so there is a relation between being the having experience and the size of the company while as we notice all the respondents almost same percentage 32% when they are only informed but not experienced.

69% of the respondents who never heard about IPD work in a small companies while (31% for mid-sized and large companies 23% that make sense as small construction companies won't have enough money, members and abilities to train it's workers and professionals to understand IPD model to give it a chance, and they usually stuck to traditional models.

As this table shows the respondents have experience IPD are working on a large sized companies and the majority of not informed respondents belong to the small sized companies that is due to the correlation between the sizes of the company, as the big companies are more financially allowances and has a more expertise to adopt IPD as usually small companies are more likely to be afraid to risk so they stick to the traditional model with less uncertainties.

8.3 COUNTRIES

COUNTRIES:

Integrated Project Delivery was created in 90s and trademarked in 2000 in USA American Institute of Architects (AIA) and other industry groups, have endorsed, published papers and held seminars on the IPD process and continuously IPD is refined and improved as a process.

44% of the our respondents were from USA and 15% from United Kingdom and less than that from Europe and Canada

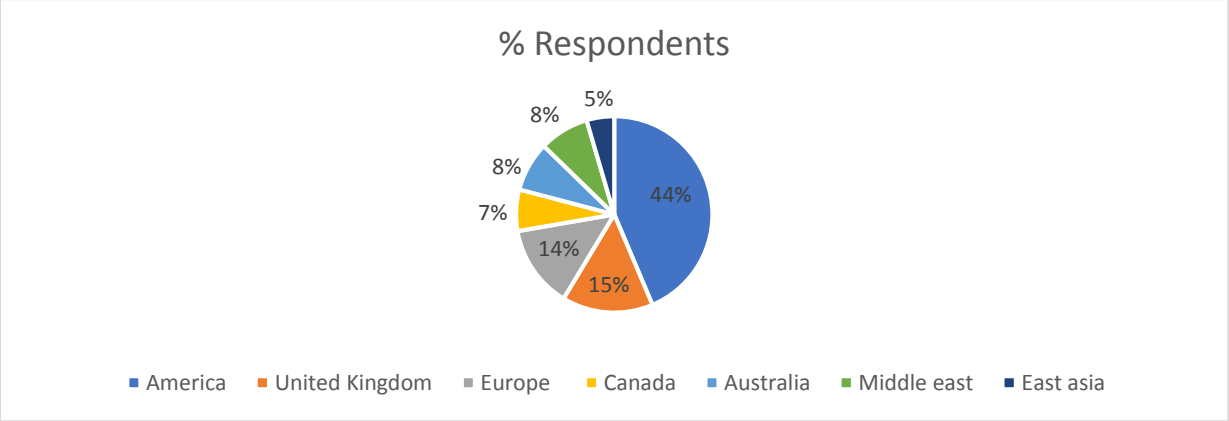


Figure 16 Countries of the respondents

8.4 BENEFITS OF IPD

The following analysis outlines the various benefits that were observed by experienced respondents on a specific IPD project. The most commonly observed benefits are Better quality 68%, cost savings _63%_, and shorter schedule (67%). Cost saving is another significant benefit observed by 63% of respondents. Improved Productivity (59%), less construction administration (51%) more prefabricated materials (33%), and fewer injuries (37%) were also observed. Other benefits suggested by respondents include less stress and friction, more productivity, and more enjoyable projects.

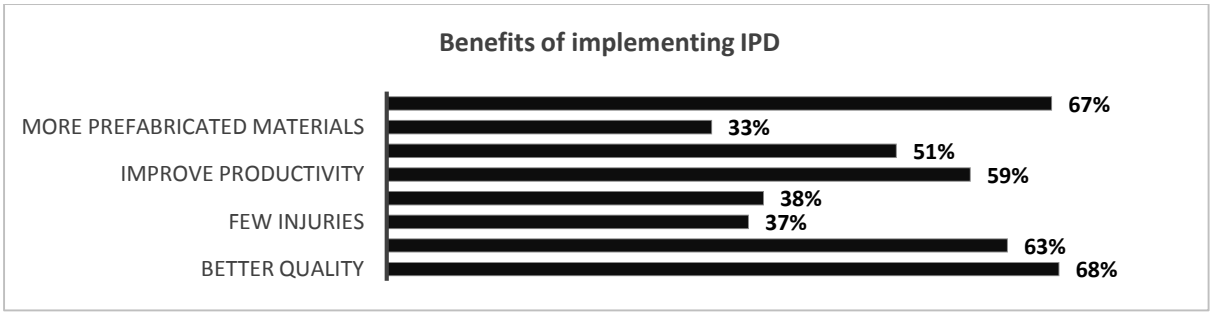


Figure 17 Benefits of IPD model

8.5 FACTORS IMPORTANT FOR ADDING VALUE TO IPD.

Respondents were asked to drag and drop a list of factors in order of importance to the success of an IPD project in According to your experience, which factor(s) contributed the most in adding value to IPD projects.

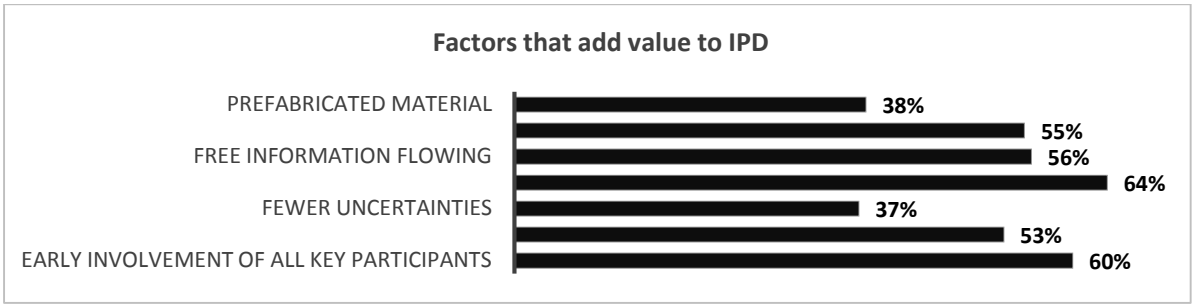


Figure 18 Factors which add value

We concluded that that Early Involvement of all key participants and focusing on quality, free flowing of information, less adjustments and sharing ideas are the most significant factor of success of IPD we more than 50% of the respondents agree choose them.

8.6 CONTRACTUAL ISSUES:

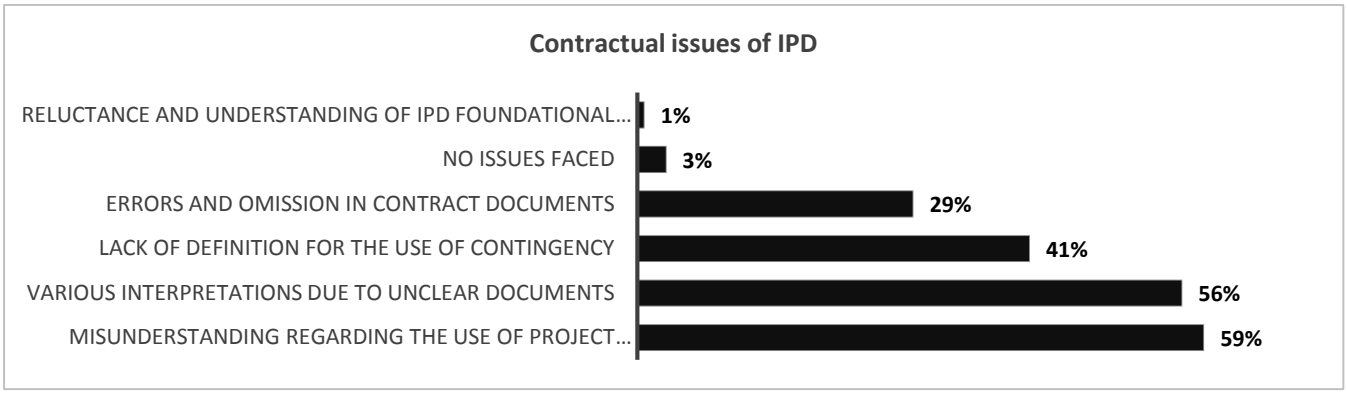


Figure 19 Contractual issues

As every method or model IPD has some problems in this study we will address the contractual problems of IPD in order to do study it we ask the respondents to pick the contractual problems that they have faced and the result is illustrated up as just 3% found no problem which is very low, and the other have faced contractual problem regardless of what is the problem, and inversely, the main three problems which half of respondents have recorded are related to ambiguity of the documents and misunderstanding of the documents and lack of definition for the use of contingency.

8.7 EXPERIENCE IN CONSTRUCTION INDUSTRY

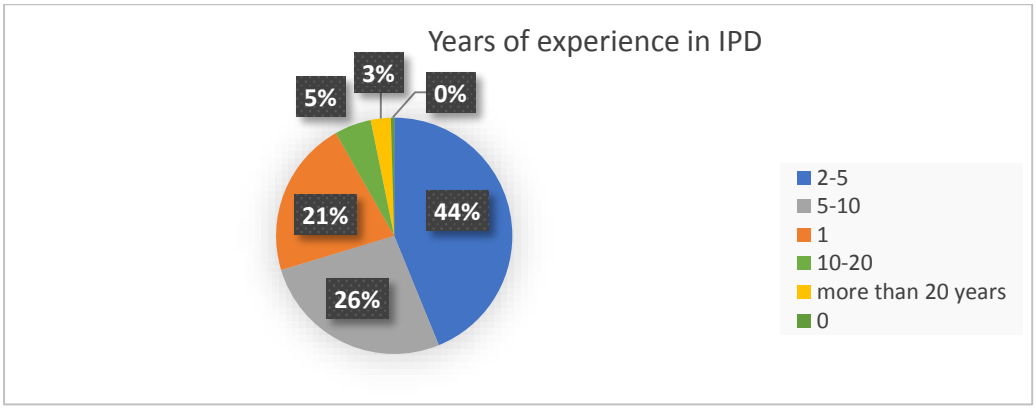


Figure 20 Years of experience in IPD

The respondents are have different years of experience in construction industry, but almost the majority of them have between 2 to 10 years of experience, we'll categorize the respondents into based on their experience and we'll use this factor.

8.8 ACTUAL EXPERIENCE IN IPD

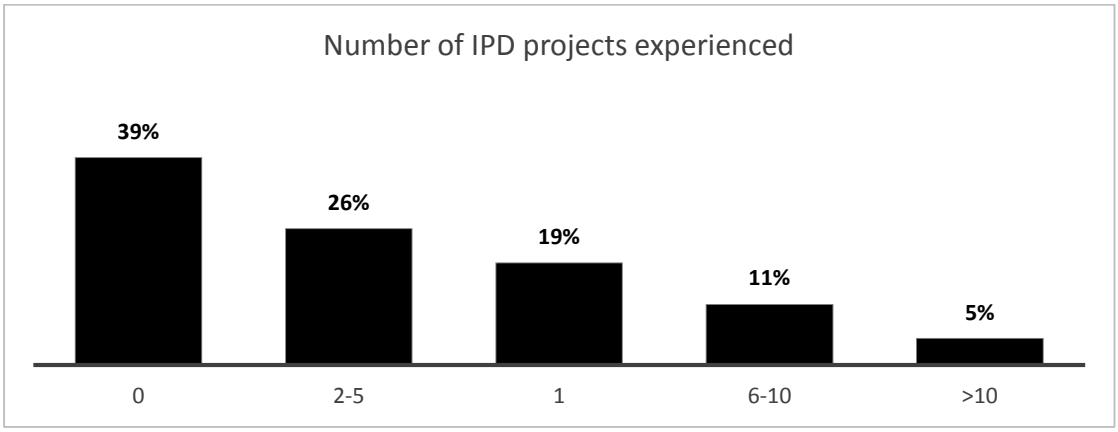


Figure 21 No, of IPD projects experienced

As the number the IPD project participated in is getting larger the lower the percentage of respondents who have implemented it and the reason its new model with many uncertainties and risks and usually owners are afraid from new methodologies even the experts had no much time since 90s to participate for more than 10 IPD projects.

8.9 REASON FOR NOT ADOPTING IPD

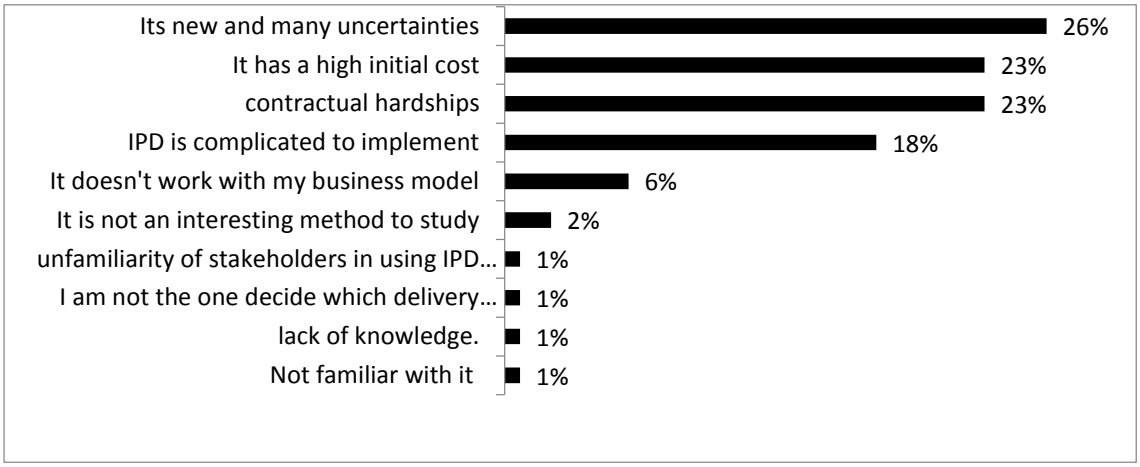


Figure 22 IPD contractual problems

The respondent who never experience IPD were asked to choose the reasons that deter them from using IPD model in their profession, the majority of 41% said the reasons to be (its new and many uncertainties, It has a high initial cost, Contractual hardship and its complexity of implementation, in this research we shed the light on contractual problems of IPD. Moreover, respondents give less importance to other reasons so in order to boost and improve the adoption rate in the future the researchers and AIA could work to solve these point as clarifying the IPD and simplifying the concept, publish more case studies that prove the contractual issues and cost problems.

About the questionnaire

- The respondents who never participated in IPD projects data are not represented in this data set.
- To analyze the development of IPD and its adoption rate, the survey will remain open until September 15th 2018, followed by a revised report.
  Some respondents commented on the challenges the IPD faces:
  i. Unwillingness to embrace IPD fully, it's hard to quit traditional roles
  ii. Understanding of what is IPD (and what it takes to succeed) is not understood fully in the industry
  iii. Poor performance by any single stakeholder can disrupt the whole team and fails the project.
  iv. Changes in personnel can effect negatively the whole project trace.

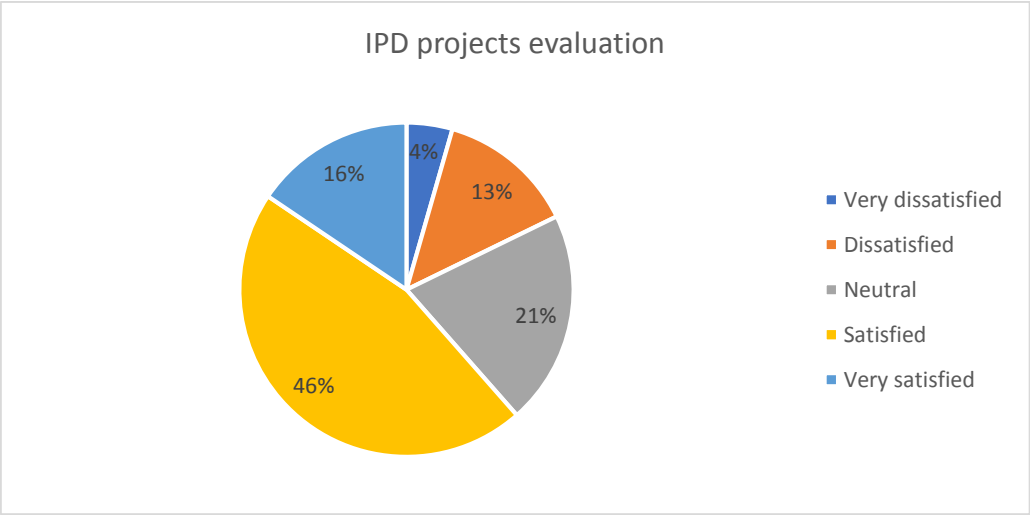


Figure 23 IPD project evaluation

This respondents were ask to express their evaluation of IPD project that they have participated in based on the performance and outcomes of the project compared to what they have experienced in tradition delivery system, as indicated the figure showed that the biggest portion for the satisfied users (46%), and (16%) were very satisfied and less than 20% of the respondents were dissatisfied and that is due to the poor outcomes that they have received after IPD project and that could be due the lack of their experienced in IPD, and this portion could pessimistic about IPD and quit it, so as a conclusion it better not to implement IPD unless you have a good team with collaborative spirit and enough knowledge about it, as its not magic as any other method it won't work without a profound understanding of its mechanism.

9 STATISTICAL ANALYSIS:

9.1 INTRODUCTION:

Statistical analysis mainly aimed to test whether IPD model could result in a superiority of the performance. Univariate analysis were conducted on the collected data to test the problems, benefits and hypothesis about tools that IPD can use as Build information modeling this analysis enabled us to get a first understanding of the data. After that we developed hypothesis will be statistically tested to help us in evaluating IPD, for each metric, normality test if the data is not normally distributed we will use **Kruskal–Wallis** one-way analysis of variance test which is non-parametric test.

The data collected from the questionnaire are non-parametric that does not assume a normal-distribution and that was proven by doing a successive normality test on the data collected to various data and also the data are not continuous as the answer is limited from 1 to 5 for the likert questions. In order to analysis the significance and the importance of the study we will use (KRUSKAL-WALLIS TEST) for more than two groups of information and also to statistically study the correlation between the data collected we will use Spearman Rho analysis.

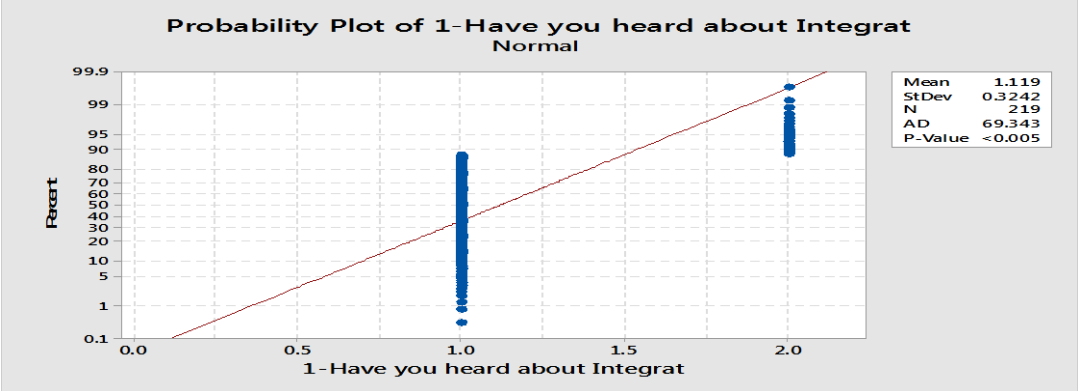


Figure 24 Normality test

Normality test with null hypothesis states that the population is normally distributed, against the alternative hypothesis that it is not normally-distributed. As the test p-value is less than the predefined significance level 5%, you we reject the null hypothesis and conclude the data are not from a population with a normal distribution.

Kruskal-Wallis analysis:

P-value ≤ α: The differences between some of the medians are statistically significant

If the p-value is less than or equal to the significance level which in this case we take as 5%, you reject the null hypothesis and conclude that not all the group medians are equal. Use your specialized knowledge to determine whether the differences are practically significant.

Figure 25 Normality test

P-value > α: The differences between the medians are not statistically significant

If the p-value is greater than the significance level, you do not have enough evidence to reject the null hypothesis that the group medians are all equal. Verify that your test has enough power to detect a difference that is practically significant.

Null hypothesis	H_0: All medians are equal
Alternative hypothesis	H_1: At least one median is different

Questions/Statistical data	Mean	Median	Standard Deviation
BIM & IPD	3.866666667	4	0.77073332
SIZE of the project	2.355555556	2	0.988490985
Traditional VS IPD	3.925925926	4	0.606305544
CONTRATUAL DIFF.	3.481481481	4	0.879720545
UNFAMILIARITY WITH IPD	3.496296296	4	1.145230695
INSURANCE DIFF	3.311111111	4	1.102687806
UPENDS BAD RELATIONS	3.844444444	4	0.596840771
MODIFICATION	3.925925926	4	0.665006224
SHORT SCHEDULE	3.792592593	4	0.82041395
IMPROVED QUALITY	3.992592593	4	0.717544489
REDUCE WASTE	3.874074074	4	0.603838834
FUTURE EXPECTATION	3.77037037	4	0.742532383

Table 8 Means of collected data

9.2 QUESTIONNAIRE SUMMARY:

The survey questions were divided into 5 parts:

1. Question to gather data about the respondents
2. To test out hypothesizes about IPD relation with BIM, size of the project, superiority over Traditional delivery methods
3. To investigate the contractual difficulties of IPD
4. Evaluate IPD by using the metrics of (short schedule, Reduce wastes, Improve quality, and decrease modifications.
5. Forecasting the adoption future of IPD through analyzing collected data:

For the first question we asked questions to categorize the respondent based on:

Informed, Experienced, Country, Stakeholder role, Years of experience in construction, Number of IPD project participated in, size of the projects.

Survey Findings

Order of the question		Q1	Q2	Q4	Q0	Q6	Q10	Q3	Q5	Q7	Q8	Q9	Q11
Number of question		1	2	3	4	5	6	7	8	9	10	11	12
Purpose		Investigating hyp.			Problems of IPD			Investigate Benefits					Future expectation
Likert question about		BIM	SIZE	Traditional VS IPD	CONTRATUAL DIFF.	UNFAMILIARITY	INSURANCE DIFF	UPENDS ADVERSARI	MODIFICATION	SHORT SCHEDULE	IMPROVED QUALITY	REDUCE WASTE	FUTURE EXP
1	5	17%	4%	14%	8%	20%	14%	10%	17%	14%	19%	11%	14%
2	4	58%	13%	65%	49%	41%	36%	65%	59%	57%	66%	65%	53%
3	3	22%	10%	20%	29%	7%	17%	24%	22%	22%	12%	23%	30%
4	2	2%	61%	1%	13%	31%	32%	1%	2%	4%	2%	1%	2%
5	1	2%	13%	0%	2%	1%	2%	0%	0%	2%	2%	0%	1%
	Total	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%

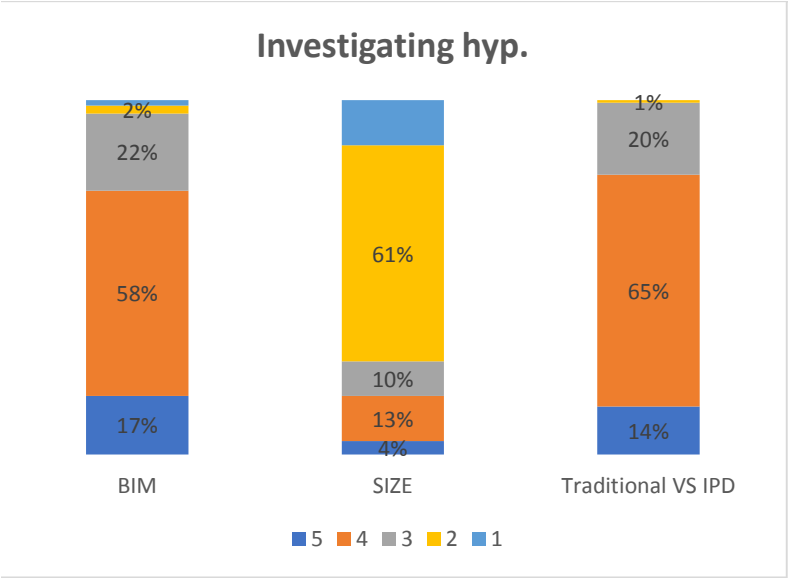


Figure 26 Tested arguments

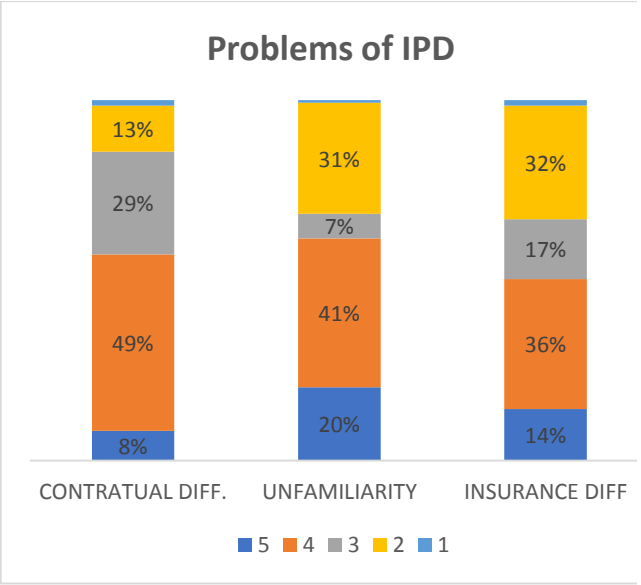


Figure 27 IPD contractual issues

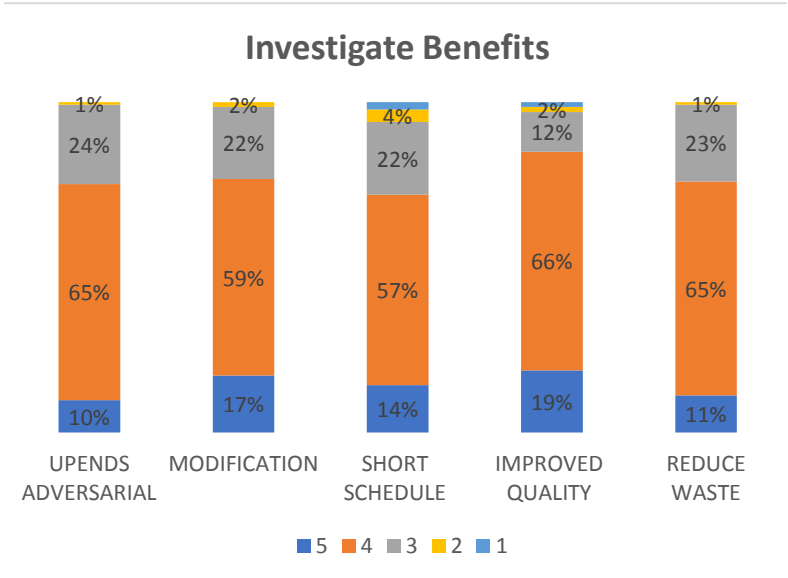


Figure 28 IPD Benefits

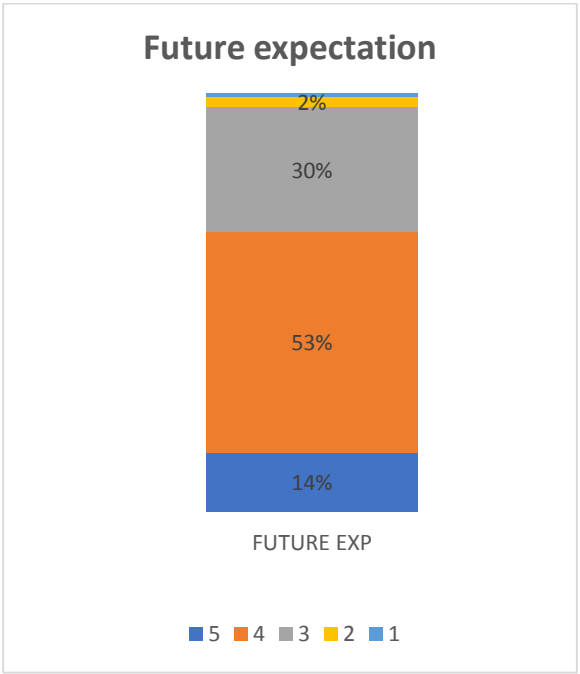


Figure 29 IPD future expectations

9.3 IPD BENEFITS EVALUATION:

In order to evaluate IPD we have to check some of its major benefits as: Short schedule, Improve Quality, Reduce wastes, Less Modifications;

UPENDS CONTRAVERSIAL RELATIONSHIPS	3.844444444
MODIFICATION	3.925925926
SHORT SCHEDULE	3.792592593
Improve Quality	3.992592593
REDUCE WASTE	3.874074074

- Integrated Project Delivery upends the often adversarial relationship between the project owner, general contractor, and architect by synchronizing everyone's goals through modeling a system of goal-sharing.
- Using IPD method decreases the number of technical, architectural, schedule, organizational modifications during the execution of the project.
- Projects developed under IPD contractual agreement have shorter schedule than projects implementing another delivery methods in its contractual contract.
- Implementing IPD methodology can improve the construction and design quality of the project.
- Implementing IPD methodology at construction projects can reduce wastes and squeeze out the biggest profit.
  The mean is almost 4 which clearly shows that the respondents approved this LIKERT statements about IPD in order to statistically prove it we conducted non-parametric tests and regression model to understand the correlation, also we tested the correlation between this variable and other factors

- Regression model

Regression model was set to study the relation between the general performance of IPD projects as independent variable with the dependent variables which are the ability of IPD to (Reduce modifications, improve quality, Upends adversarial relations). After inputting the collected data we obtained this equation;

- **Regression Equation**

Average Performance of IPD projects = 3.062 + 0.070 UPENDS ADVERSERIAL RELATIONS + 0.069 IMPROVE QUALITY + 0.031 Reduce MODIFICATION - 0.0517 SHORT SCHEDULE

Analysis of Variance

Source	DF	P-Value
Regression	4	0.0198
UPENDS ADVERSERIAL RELATIONS	1	0.0266
IMPROVE QUALITY	1	0.0398
Reduce MODIFICATION	1	0.0076
SHORT SCHEDULE	1	0.0170

Figure 30 ANOVA for benefits of IPD

- **Correlations between the investigated benefits of IPD projects**.

	UPENDS adversarial relations	MODIFICATION	SHORT SCHEDULE	IMPROVE QUALITY
MODIFICATION	0.153			
	0.077			
SHORT SCHEDULE	0.226	0.201		
	0.008	0.020		
IMPROVE QUALITY	0.126	0.155	0.285	
	0.144	0.072	0.001	
REDUCE WASTE	0.180	0.288	0.221	0.087
	0.037	0.001	0.010	0.316

Cell Contents
Spearman rho+
P-Value

The relations between all the factors of benefits of using IPD is positive as all the spearman-rho values are positive but they are not high which shows that the benefits are not strongly related as its different from one project to another as the most successful IPD projects can't realize all the benefits at once as previous case studies in literature review showed that each project benefited from using IPD model at certain levels, all the relations were significant as the P-value < 5% except for the relation between the (Reduce waste and Improved quality) is not significant and it could've been happened by chance.

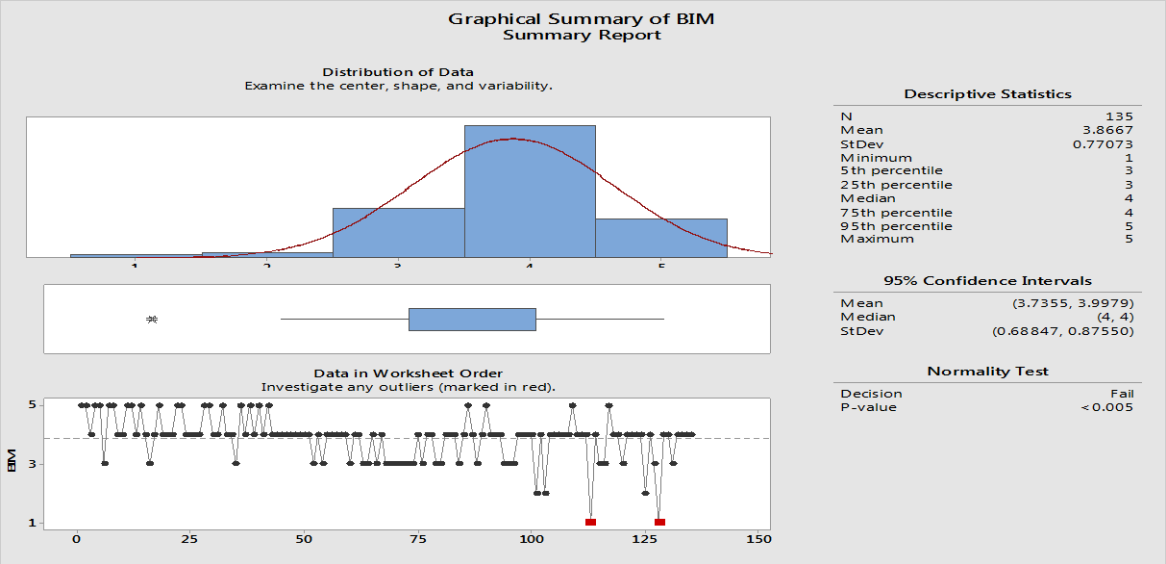
9.4 TESTING HYPOTHESIS:

9.4.1 BIM

In order to test for how successful the test we have to make sure to have the value

Hypothesis: The productivity and efficiency of construction projects can be optimized by implementing IPD methodology and using BIM tool together to design, plan, construct. The mean of the answers is 3.866>3 and the statistical Kruskal-Wallis test is significant as P<5% beside that when we study the linear regression we got the equation:

Performance of IPD projects= 3.504 +0.0075 BIM



- BIM and IPD

Number of IPD projects	N	Median	Z-Value
>10	11	2	0.51
0	1	5	1.67
1	42	2	-1.75
2-5	56	2	0.64
6-10	25	2	0.55
Overall	135		

Table 9 Kruskal-Wallis test BIM hypothesis

Method	DF	H-Value	P-Value
Not adjusted for ties	4	5.59	0.232
Adjusted for ties	4	7.18	0.127

The chi-square approximation may not be accurate when some sample sizes are less than 5.

No enough evidence to reject the null hypothesis that the group medians are all equal.

- BIM and years of experience in construction industry

Descriptive Statistics

Years in Const. industry	N	Median	Z-Value
1	20	3.0	-3.31
10-20	10	4.5	2.58
2-5	51	4.0	0.15
5-10	48	4.0	0.51
>20	6	4.0	0.89
Overall	135		

Method	P-Value
Not adjusted for ties	0.002
Adjusted for ties	0.000

Table 10 Kruskal-Wallis BIM and Experience

The P-value <5% so we reject the null hypothesis , there is a significant difference between the medians, that is expected result as the more expert in construction industry the respondent will understand the problems of this industry and the need of BIM

- BIM and Number of IPD project performed

No. IPD projects	N	Median	Mean Rank	Z-Value
>10	11	4	91.9	2.11
0	1	5	124.0	1.44
1	42	4	54.1	-2.77
2-5	56	4	65.0	-0.75
6-10	25	4	85.3	2.44
Overall	135		68.0	

Table 10 Kruskal-Wallis BIM and No. IPD projects

Method	P-Value
Not adjusted for ties	0.002
Adjusted for ties	0.000

The P-value <5% so we reject the null hypothesis is untrue, as we can notice the more experienced the respondent in applying IIPD model the more he is confident about the importance of the usage of BIM tool and IPD model together, as he could've experienced IPD project with and other without it.

BIM and the size of the project

Size IPD project	N	Median	Mean Rank	Z-Value
Large	54	4	76.5	2.06
Mid-sized	50	4	69.5	0.34
Small	31	4	50.8	-2.79
Overall	135		68.0	

Table 11 Kruskal-Wallis BIM and size of project

Method	P-Value
Not adjusted for ties	0.013
Adjusted for ties	0.004

Unadjusted p-value is always greater than the adjusted p-value, it is considered the more conservative estimate.

So, this test in significant as the p-value<5% The size of the project is significantly affects the respondent's attitude about how beneficial is using BIM and IPD together as we can notice the medians are all 4 so the respondents agree on hypothesis made.

- BIM and way of experiencing IPD model

Experienced /Not	N	Median	Z-Value
Both above	5	4	0.87
By Implementing it	99	4	0.04
By researching it	31	4	-0.43
Overall	135		

Method	P-Value
Not adjusted for ties	0.644
Adjusted for ties	0.574

Table 12 Kruskal-Wallis BIM and Mode of experiencing IPD

Unadjusted **p-value** is always greater than the **adjusted p-value**, it is considered the more conservative estimate.

So, this test in insignificant as the p-value>5% this could have been happen by chance. The size of the project doesn't directly affects the respondent's attitude about how beneficial is using BIM and IPD together.

- BIM and The country of the respondent

Method	P-Value
Not adjusted for ties	0.026
Adjusted for ties	0.002

Table 13 Test BIM and country of IPD

If the p-value is less than or equal to the significance level, you reject the null hypothesis and conclude that not all the group medians are equal this test in insignificant as the p-value>5% this could have been happen by chance. The country of the project doesn't directly affects the respondent's attitude about how beneficial is using BIM and IPD.

- BIM and way of experiencing IPD model

Way of experience	N	Median	Mean Rank	Z-Value
Both above	5	4	83.0	0.87
By Implementing it	99	4	68.1	0.04
By researching it	31	4	65.3	-0.43
Overall	135		68.0	

Method	P-Value
Not adjusted for ties	0.644
Adjusted for ties	0.574

Unadjusted **p-value** is always greater than the **adjusted p-value**, it is considered the more conservative estimate.

So, this test in insignificant as the p-value>5% this could have been happen by chance. The size of the project doesn't directly affects the respondent's attitude about how beneficial is using BIM and IPD together.

- BIM and The country of the respondent

Method	P-Value
Not adjusted for ties	0.026
Adjusted for ties	0.002

This test in insignificant as the p-value>5% this could have been happen by chance. The country of the project doesn't directly affects the respondent's attitude about how beneficial is using BIM and IPD together.

P-value is greater the significance level, we don't have enough evidence to reject the null hypothesis that the group medians are all equal, the median in most of the roles is **4** which is agree, this test is not significant as p greater than 5%.

- Number of IPD project performed and superiority of IPD

Number of IPD projects	N	Median	Z-Value
>10	11	4	1.54
0	1	3	-1.36
1	42	4	-3.49
2-5	56	4	1.00
6-10	25	4	2.11
Overall	135		

Method	P-Value
Not adjusted for ties	0.002
Adjusted for ties	0.000

Table 14 Kruskal-Wallis testing superiority of IPD

If the p-value is less than or equal to the significance level, you reject the null hypothesis and conclude that not all the group medians are equal. The result is significant and indicates most the respondents no matter how many IPD project they have performed agree on our hypothesis of the superiority of IPD over traditional DM.

IPD adoption future

Would you stand with optimistic believers of IPD who think that IPD method has a promising future and it will dominate over traditional delivery methods in the near future?

- IPD experience & IPD adoption future expectation

Number of IPD projects	N	Median	Z-Value
>10	11	4	1.87
0	1	5	1.49
1	42	3	-4.70
2-5	56	4	1.35
6-10	25	4	2.23
Overall	135		

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

Table 15 Adoption of IPD in future and experience

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer was which is agree (4) regardless how many IPD project they have implemented before and also a good portion were not sure and they answered by neutral (3).

- Experience Construction INDUSTRY & IPD adoption future expectation

Y. experience in construction	N	Median	Z-Value
1	20	3	-3.66
10-20	10	4	1.76
2-5	51	4	-2.27
5-10	48	4	3.95
more than 20 years	6	4	0.23
Overall	135		

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

`

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer was which is agree (4) regardless of how many years have they experienced in construction industry before and also a good portion were not sure and they answered by neutral (3).

- Size of the company & & IPD adoption future expectation

Size Project	N	Median	Z-Value
Large	54	4	3.46
Mid-sized	50	4	-0.24
Small	31	3	-3.76
Overall	135		

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer was which is agree (4) regardless of the size and complexity of IPD project also a good portion were not sure and they answered by neutral (3).

9.4.2 SIZE

IPD method should be reserved only for large, complex projects rather than small, simple projects.

The mean value is 2.35 which is that informed and experienced respondents rejected this likert statement, also the Kruskal-Wallis tests shows that rejection of the respondents to this statement.

Conclusion: IPD is not dependent on the size of the company and the complexity of the project, as only it can applied on small project, actually IPD is a model as we studied before there were companies with extremely different budget and size and this model achieved success on both.

IPD is appropriate for all firm sizes, but the implementation details must reflect the size and structure of the involved firms and the size and duration of the project. For example, IPD often involves deferring all or a portion of profit until project success is determined. In addition, IPD requires more effort at the first stages. These changes affect cash flow. The firm size, especially in relation to the project size, may alter when profit should be determined (perhaps in phases) and how risk adverse the owner is, When developing an IPD project, the parties must know their differences as ultimately they want to create a unified team.

- SIZE and the number of IPD projects

Number of IPD projects	N	Median	Z-Value
>10	11	2	0.51
0	1	5	1.67
1	42	2	-1.75
2-5	56	2	0.64
6-10	25	2	0.55
Overall	135		

Method	P-Value
Not adjusted for ties	0.232
Adjusted for ties	0.127

This test in insignificant as the p-value>5% this could have been happen by chance. The number of the project doesn't directly effects the respondent's attitude about whether **IPD method should be reserved only for large, complex projects rather**

Experience	N	Median	Mean Rank	Z-Value
1	20	2	59.9	-1.01
10-20	10	4	98.4	2.55
2-5	51	2	62.2	-1.35
5-10	48	2	71.2	0.70
more than 20 years	6	2	68.3	0.02
Overall	135		68.0	

Method	P-Value
Not adjusted for ties	0.080
Adjusted for ties	0.030

Table 11 BIM and Experience

- Size and experience IN construction industry

This test in insignificant as the p-value>5% this could have been happen by chance. The years of experience in construction industry doesn't affects the respondent's attitude about whether IPD method should be reserved only for large, complex projects rather small, simple projects. but the medians are tending to disagree.

- Size and the stakeholder role of the respondents

Method	P-Value
Not adjusted for ties	0.193
Adjusted for ties	0.080

This test in insignificant as the p-value>5% this could have been happen by chance. Role of the stakeholder doesn't affects the respondent's attitude about whether IPD method should be reserved only for large, complex projects rather small, simple projects.

- Size and the country of the respondent

Method	P-Value
Not adjusted for ties	0.040
Adjusted for ties	0.004

This test in insignificant as the p-value>5% we reject, the null hypothesis this could have been happen by chance. The country that the IPD was implemented by the respondent doesn't significantly affect attitude about whether IPD method should be reserved only for large, complex projects rather small, simple projects.

This test in insignificant as the p-value>5% this could have been happen by chance. The country that the IPD was implemented by the respondent doesn't significantly affect attitude about whether IPD method should be reserved only for large, complex projects rather small, simple projects.

9.4.3 TRADITIONAL DM.

Implementing IPD more value and better outcomes than using any of traditional delivery methods.

This likert statement aimed to make a comparison between IPD and Traditional delivery method as Design-Build, DDB and CM… the mean=3.925925926>3.5≈4 so the respondent agree on this statement in order to statistically state that we conducted a kruskal-wallis analysis as the data in not normally distributed.

- IPD vs traditional dM

IPD vs Traditional delivery method: Implementing IPD more value and better outcomes than using any of traditional delivery methods.

- Correlations between Hypothesis concerning IPD projects.

	BIM	SIZE
SIZE of the project	0.177	
	0.040	
Traditional VS IPD	0.135	-0.124
	0.119	0.153

Using BIM benefits and Size of the projects have a positive relation that could be explained as BIM tool is usually used with the big size projects as BIM tool could be expensive and small projects are less likely to use IPD.

The other relations is not significant as the P<5%

- Years of exp. IN CONSTRUCTION industry and superiority of IPD

Y. experience in construction	N	Median	Z-Value
1	20	4	-0.89
10-20	10	4	0.61
2-5	51	4	-2.39
5-10	48	4	2.64
more than 20 years	6	4	0.25
Overall	135		

Method	P-Value
Not adjusted for ties	0.058
Adjusted for ties	0.012

Table 12 IPD and Traditional DM

P-value is greater than or equal to the significance level, we don't have enough evidence to reject the null hypothesis that the group medians are all equal, the median in most of the cases is 4 which is agree, this test is significant as p less than 5%.

9.4.4 IPD ISSUES

In this part we will investigate some contractual problems of IPD, unfamiliarity of IPD:

The complexity of IPD insurance contracts is a big obstacle that deters the owners from using IPD contracts,

The mean is 3.31<3.5≈3 so we conclude that the respondents are neutral or unsure about if IPD insurance contracts deter the owners from adopting **IPD**

Contractual difficulties and ambiguities stand in the way of using IPD contractual agreements.

The mean =3.5 which indicates that the respondents in average agree in contractual being a problem that deter them from using

Which reflect that the statement is true and we have conducted test to test it with other factors also we have studied the relationship with other factors

9.5 IPD CONTRACTUAL PROBLEMS

9.5.1 CONTRACTUAL HARDSHIPS

Contractual difficulties and ambiguities stand in the way of using IPD contractual

Number of IPD projects	N	Median		Z-Value
>10	11	4	89.6	1.91
0	1	5	126.0	1.49
1	42	2	39.6	-5.66
2-5	56	4	73.6	1.41
6-10	25	4	91.2	3.28
Overall	135		68.0	

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

Table 13 Testing Insurance hypothesis of IPD

Contractual difficulties and Number of IPD projects

Number of IPD projects	N	Median	Mean Rank	Z-Value
>10	11	4	67.9	-0.01
0	1	3	40.0	-0.72
1	42	3	52.6	-3.08
2-5	56	4	74.1	1.53
6-10	25	4	81.4	1.90
Overall	135		68.0	

Method	P-Value
Not adjusted for ties	0.023
Adjusted for ties	0.010

Table 14 Testing contractual hardship

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer was which is agree (4) regardless how many IPD project they have implemented before and also a good portion were not sure and they answered by neutral (3), in total we realize that the test approve this hypothesis.

- Contractual difficulties AND YEARS in construction industry

Y. experience in construction	N	Median	Z-Value
1	20	2.5	-3.80
10-20	10	4.0	0.11
2-5	51	4.0	0.45
5-10	48	4.0	2.73
more than 20 years	6	3.0	-0.99
Overall	135		

Method	P-Value
Not adjusted for ties	0.001
Adjusted for ties	0.000

Table 15 Contractual diff and years in construction industry

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer who answered agree (4) are more expert and their opinion is more likely to be realistic regardless of how many years have they experienced in construction industry before and also a most expert portion median were not sure and they answered by neutral (3) the least experienced where more likely to reject it.

9.5.2 UNFAMILIARITY

The unfamiliarity of participants who are using IPD method leads to failure of the project goals.

- Unfamiliarity and Years in construction industry

Y. experience in construction	N	Median	Z-Value
1	20	2	-4.79
10-20	10	4	1.47
2-5	51	3	-2.53
5-10	48	4	4.59
more than 20 years	6	4	1.69
Overall	135		

Table 16 Experience and Unfamiliarity

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer who answered agree (4) are more experienced and their opinion is more likely to be realistic regardless of how many years above 5 have they experienced in construction industry before and also 2-5 years respondents median were not sure and they answered by neutral (3) the least experienced where more likely to reject it. So we could approve this disadvantage to be true.

- Unfamiliarity and Number of IPD projects.

Number of IPD projects	N	Median	Z-Value
>10	11	4	2.11
0	1	4	0.32
1	42	2	-5.90
2-5	56	4	1.11
6-10	25	4	4.07
Overall	135		

Table 17 Test unfamiliarity problem of IPD

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant as the majority of the respondent's answer who answered agree (4) are more experienced and their opinion is more likely to be realistic regardless of how many IPD project have they experienced implementing, before and also 42 respondents who answered disagree 2 median (have only 1 year of experience).

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant, the majority of the respondents who agreed (4) are the one who practiced IPD projects the most “more than 2 projects to more than 10”And their opinion is more likely to be realistic, 42 have disagreed.

9.5.3 INSURANCE AND YEARS OF EXPERIENCE IN CONSTRUCTION INDUSTRY

The p-value is less than the significance level 5%,, we can reject the null hypothesis and conclude that not all the group medians are equal, the test is significant, the majority of the respondents who agreed (4) are the one who practiced IPD projects the most ”more than 5 projects to more than 10”

Y. experience in construction	N	Median	Mean Rank	Z-Value
1	20	2	37.0	-3.84
10-20	10	4	72.2	0.35
2-5	51	3	59.4	-1.99
5-10	48	4	86.2	4.02
more than 20 years	6	4	91.3	1.49
Overall	135		68.0	

Method	P-Value
Not adjusted for ties	0.000
Adjusted for ties	0.000

While a big portion of those who have 2 to 5 years of experience in construction industry were neutral.

Regression Analysis

We have made a Regression model to test the relation between the performance and the benefit factors of IPD.

Performance of IPD projects = 2.989 + 0.057 UPENDS ADVERSERIAL RELATIONS
+ 0.0577 IMPROVE QUALITY + 0.025 Reduce MODIFICATION

Analysis of Variance

Source	DF	P-Value
Regression	3	0.861
UPENDS ADVERSERIAL RELATIONS	1	0.636
IMPROVE QUALITY	1	0.563
Reduce MODIFICATION	1	0.820
Error	131	
Lack-of-Fit	23	0.105
Pure Error	108	
Total	134	

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.815404	0.57%	0.00%	0.00%

Fits and Diagnostics for Unusual Observations

9.5.4 CORRELATIONS BETWEEN THE MOST COMMON CONTRACTUAL PROBLEMS IN IPD CONTRACTS.

	CONTRATUAL DIFF.	UNFAMILIARITY
UNFAMILIARITY	0.382	
	0.000	
INSURANCE COMPLEXITY F	0.365	0.685
	0.000	0.000

Cell Contents
Spearman rho
P-Value

1. The unfamiliarity of participants who are using IPD method leads to failure of the project goals.
2. Contractual difficulties and ambiguities stand in the way of using IPD contractual agreements.
3. The complexity of IPD insurance contracts is a big obstacle that deters the owners from using IPD contracts.

As the numbers shows there is a **positive** relationship between the opinions of the respondents toward IPD contractual problems and their effect on IPD project and on the rate of the adoption as a failure could make potential respondents more worried and careful about adopting this new model, and the P-value is less than 5% in all cases which means that these correlations are significant

The correlation between the those three LIKERT statements is positive but not strong as the coefficients (spearman rho) <0.4 while the relation while we have a stronger relation between the Unfamiliarity and Insurance complexity 0.685 ≈ 0.7 and we can comment that if the participants are not familiar with IPD model the more likely they will face problems during the project the thing that will require claiming insurance and other conflicts between participants and as the contractual contracts are ambiguous and complex the situation will be undetermined and the relation will be war-like which violate one of the principles of IPD and ultimately leads to failure of the project and consequently slower the adoption.

10 CONCLUSION

The finding of this study shows the benefits, obstacles and the principles of IPD which add value to this delivery system and how we implement those principles to add-value to the construction project, this survey proved the win-win relationship between the stakeholders to squeeze out profit by risk-award sharing model.

IPD adoption is still limited and it is mainly relate to awareness and appreciation of industry personnel are within dissatisfaction level. Based on the analysis of the collected data we could conclude that

This research proved statistically significant evidence of superiority of IPD over traditional system by a comprehensive performance metric which is mix of cost, schedule, performance, efficiency factors.

This researcher confirmed the following information:

About respondent:

- Despite that IPD is more know, but the adoption is still rate slow comparatively.
- Majority of IPD users are from USA and then UK and its less implemented in other countries which is less advanced or with low population.

1. **IPD benefits**

- Integrated Project Delivery is efficient in optimizing construction planning, reducing waste, cost, time, and risk, and improving the productivity of construction projects as its superiority over Traditional delivery methods is proved by our analysis.
- The productivity and efficiency of construction projects can be optimized by implementing IPD
- Using IPD method decreases the number of technical, architectural, schedule, organizational modifications during the execution of the project.
- IPD often upends adversarial relationship by unifying goals through goal & risk sharing system.
- Using IPD improve quality, shorten schedule, reduce waste to squeeze profit

2. **IPD tested hypothesis**

- IPD display a superior performance over traditional delivery systems and that was proven statistically and analytically beside IPD implementing is proved to save time and cost and eventually better outcomes
- The adoption of IPD will increase in the near future
- The size of the project and the company is not a big deal were IPD could be used for all sizes of projects (small, mid-sized and large).

3. **IPD contractual problem**

- Contractual difficulties and ambiguities slowed the adoption of IPD.
- Unfamiliarity of participant with IPD method fails the IPD project.
- Complexity of insurance contracts deter potential adopters.

4. **General about IPD**

- Uncertainties, initial high cost, contractual hardships, and Complexity of implementation of IPD are the main reason behind not adopting IPD.
- Shorten schedule cost saving better quality improve productivity less construction administration are the main benefits derived from IPD

- Early involvement, focusing on quality, free information flowing and sharing idea are the key factors that contributes in adding value to IPD more than any other delivery method

This research showed that integrated project delivery is efficient in optimizing construction planning. Reduce waste, cost, time, risk which will result in improving productivity of construction projects, and adopting it with focusing to solve its problems could end the age of poor productivity in construction industry.

Future Research Opportunities

This research is an opportunity for new researches to research and go deep on the reasons of not adopting IPD to find a solution to the contractual that we discussed before and specially those reasons which the respondents picked the most wit more than 50%, also the adoption record of IPD for the sample could be compared in the future with other samples of professional to track the development of IPD adopters.

Integrated Project Delivery Evaluation(IPD).

Welcome to a research questionnaire about the practice of Integrated Project Delivery (IPD).
I am an MSc thesis student at the Dept. of Management and Production Engineering of Politecnico di Torino, a technical university in Italy. I am conducting a questionnaire that aims to investigate the adoption of IPD and to evaluate its efficiency in optimizing construction planning, reducing waste, cost, time, and risk, and improving the productivity of construction projects.
This questionnaire targets a wide range of professionals in the construction industry who have experienced using IPD or researchers who have studied IPD as a methodology or analyzed previous IPD case studies.
The data collected from this questionnaire will enable me and my research team to measure the effectiveness of IPD in achieving the ultimate goals of project success and to draw suggestions to help practitioners in deciding to adopt IPD as a project delivery methodology.
Thank you for taking your time and efforts to fill in the questionnaire, it will take you only about 10 minutes.

If you care to leave your contact information I will be happy to disclose the final results of this survey.

Politecnico di Torino and I guarantee that all information provided will be considered confidential and used for research purposes anonymously, preventing individuals and/or single organizations from being identifiable. Also, your given contact information, if any, will be kept strictly confidential and not used for any purpose outside the scope of this questionnaire.

In which country have you experienced implementing/studying construction projects that use IPD method? *

Choose

What is your Stakeholder role in construction projects? *

- ○ Construction manager
- ○ General contractor
- ○ Engineer
- ○ Architect
- ○ Project Manager
- ○ Researcher
- ○ Owner
- ○ Other:

What is the size of your organization?

Organization size is based on number of employees: Small (0 – 100), Mid-Sized (101– 1000), Large (1001 &above)

- ○ Small
- ○ Mid-sized
- ○ Large

About the respondent

This question is to classify the respondents and to know the type of experience they have about IPD.

Have you heard about Integrated Project delivery? *

If "NO" the next question answer have to be "Non of both" Integrated Project Delivery (IPD) is a powerful delivery model because it upends the often adversarial relationship between the project owner, general contractor, and architect. In most contracts the financial goals between these parties conflict and what's good for the owner hurts the architect's bottom line and bigger architectural profits leave the general contractor in danger of coming out in the red. Competition can bring out the best in people but it makes little sense to compete over the same resources needed to deliver a great project.

- ○ Yes
- ○ No

Have you experienced Integrated project delivery method by implementing or researching/studying it? *

Answering "Non of both" will end the survey

- ○ By Implementing it
- ○ By researching it
- ○ Both above
- ○ None of both

For how many years have you been working in the construction industry in general? *

- ○ 0
- ○ 1
- ○ 2-5
- ○ 5-10
- ○ 10-20
- ○ more than 20 years

In how many projects have you experienced implementing/studying IPD so far?

- ○ 0
- ○ 1
- ○ 2-5
- ○ 6-10
- ○ >10

According to your knowledge of using IPD method choose the extent in which you agree with the following statements?

This section targets the respondents who have experienced using IPD by implementing it on projects and researchers who have studied IPD case studies.

Contractual difficulties and ambiguities stand in the way of using IPD contractual agreements.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The productivity and efficiency of construction projects can be optimized by implementing IPD methodology and using BIM tool together to design, plan, construct

BIM: Build Information Modeling an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

IPD method should be reserved only for large, complex projects rather than small, simple projects.

IPD is believed to require a significant initial cost investment and additional design efforts, IPD is claimed to be beneficial in repetitive facilities rather than the unique one-time projects

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Integrated Project Delivery upends the often adversarial relationship between the project owner, general contractor, and architect by synchronizing everyone's goals through modeling a system of goal-sharing.

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

Implementing IPD more value and better outcomes than using any of traditional delivery methods.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Using IPD method decreases the number of technical, architectural, schedule, organizational modifications during the execution of the project.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The unfamiliarity of participants who are using IPD method leads to failure of the project goals.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Projects developed under IPD contractual agreement have shorter schedule than projects implementing another delivery methods in its contractual contract.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Implementing IPD methodology can improve the construction and design quality of the project.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Implementing IPD methodology at construction projects can reduce wastes and squeeze out the biggest profit.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The complexity of IPD insurance contracts is a big obstacle that deters the owners from using IPD contracts.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

In average How would you evaluate the performance and outcomes of the projects that you have participated in or Studied about? *

- ○ Very satisfied
- ○ Satisfied
- ○ Neutral
- ○ Dissatisfied
- ○ Very dissatisfied

Would you stand with optimistic believers of IPD who think that IPD method has a promising future and it will dominate over traditional delivery methods in the near future?

	1	2	3	4	5	
Strongly disbelieve	○	○	○	○	○	Strongly believe

According to your knowledge and experience, check the boxes.

You can check more than one box

Which contractual issues have you faced by using IPD contractual agreements?

- ☐ Errors and omission in contract documents
- ☐ Various interpretations due to unclear documents
- ☐ Misunderstanding regarding the use of project contingency
- ☐ Lack of definition for the use of contingency
- ☐ No issues faced
- ☐ Other:

According to your experience, which factor(s) contributed the most in adding value to IPD projects?

- [ ] Free information flowing
- [ ] Less adjustment
- [ ] Early involvement of all key participants
- [ ] Prefabricated material
- [ ] Fewer uncertainties
- [ ] Focusing on quality
- [ ] Entire team sharing ideas
- [ ] Other:

What benefit(s) have you observed by implementing IPD methodology on construction projects?

- [ ] Fewer change orders
- [ ] Cost saving
- [ ] Shorter schedule
- [ ] Less construction administration
- [ ] Few injuries
- [ ] More prefabricated materials
- [ ] Better quality
- [ ] Improve productivity
- [ ] Other:

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