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INTEGRATED PROJECT DELIVERY AND ASSOCIATED RISK REDUCTION IN CONSTRUCTION PROJECTS IN EGYPT

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ABSTRACT

This study investigates the effect of using the Integrated Project Delivery IPD approach on reducing risks of construction projects in Egypt. The study started by identifying different Project Delivery Systems PDS highlighting its characteristics and inherited problems. The study also introduced IPD and its key principles as a proposed tool reducing construction risks. An updated list of construction risks was generated after comprehensive literature review. A questionnaire survey was developed to measure the anticipated reduction in construction risks quantitatively under the assumption of applying IPD. The survey was distributed to Contractors, Consultants, and Employers while collected data were analyzed and results' reliability was found consistent using Statistical Package for the Social Science SPSS. Significance anticipated risk reduction was prominent for "Design" and "Management" risks while moderate anticipated reduction was noticeable for "Construction" and "Contractual" risks and slight anticipated reduction was found for "Economic" and "Political" risks. The study also identified the Relative Importance Index RII for the IPD key principles to sort them based on practitioners' feedback. The study concluded that applying IPD approach in Egypt is promising and many benefits could be gained due to anticipated risk reduction that may occur in construction of building projects in Egypt.

KEYWORDS: Integrated Project Delivery, IPD, Construction Risk, Risk Reduction.

1. INTRODUCTION

Construction industry is not like other industries due to its complex nature; interrelated activities; extensive communication; continuous conflicts; and potential risks related to decision making. Construction industry is notorious for high levels of conflicts and disputes, within a project life cycle, a large number of separate firms are involved. Failure by one party can impact all those engaged in the project and, as

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projects often have long durations during which macro-economic circumstances can alter, it is inevitable that disputes will arise [1]. That is why construction projects are considered riskier compared to other business activities [2].

Correlation between construction risks and the PDS was proofed, it was concluded that projects are subjected to many risks that could be derived from many reasons, among which is the improper selection of the PDS [1].

PDS is a contractual structure and a compensation arrangement that the owners use to acquire a completed facility that meets their needs [3, 4]. Another definition was introduced stating that PDS is “the comprehensive process of assigning the contractual responsibilities for designing and constructing a project” [5, 6].

PDS is also defined as a method for procurement by which the owner’s assignment of “Delivery” risk and performance for design and construction has been transferred to another party {parties}; these parties typically are the design entity who takes responsibility for the design and the contractor who takes responsibility for the performance of the construction [7].

Despite the fact that right selection of the PDS does not guarantee the accomplishment of the project [1] but the judgment to select the appropriate PDS to execute a construction project is fundamental.

Generally; Egyptian construction industry stakeholders {Employers, Consultancy Firms, Project Management Firms, and Contractors} do not have a specific procedure for applying PDS to implement projects, they base their choice on knowledge and experience. For this reason, employers use PDS that is compatible with their organizations’ demands [1].

Having demonstrated all the above; it’s now apparent that PDS is one of the vital factors affecting project success. As such; this paper would shed light on the most widespread PDS, comprehensively discuss the IPD as the most recent PDS, and then calculate the anticipated reduction of construction risks’ magnitude/index that could be achieved under the assumption of applying IPD in construction of building projects in Egypt.

2. LITERATURE REVIEW

Previous researches were reviewed collecting the characteristics of different PDS with a focus on the IPD to define its key principles and the pillars that make IPD one of the most favorable systems recently.

2.1 Prevalent PDS

The most prevalent PDS currently used and demonstrated in several researches of the construction industry are: design-bid-build {DBB}, design-build {DB}, construction management at risk {CM/GC}, construction management as program management {CM/PM} [3]. Different characteristics of these PDS and the main idea of each are illustrated in Fig. 1.

In general, current systems do not facilitate collaboration or innovation because of creating insuperable barriers between stakeholders due to lack of trust and shifting of risk. However, researches and approaches from other disciplines show that outstanding results can only be achieved if synergies are identified and used for the benefit of the whole project. Therefore, the mindset needs to change from "best for self" to "best for project" and cooperation needs to be enforced by the delivery method itself [8].

Current PDS have many disadvantages also such as: nonexistence of one contract agreement supporting adequate alliancing between parties, unhealthy competitive work atmosphere because every party is keen to achieve his organization's goals only by maximizing profit aggressively without thinking of project benefits, disagreements and disputes are common between parties, every party is keen only to avoid legal liability of the mistakes to gain maximum interest, Finally the risks are not fairly distributed between parties, on contrary; employers usually try to transfer most of construction risks to the contractors. While contractors in their turn try to resist by lowering quality of work, increase claims, and manage poor design processes. This unhealthy interaction between the two parties usually results in delays and/or cost overrun and leads to disputes that may escalate to litigation or even arbitration.

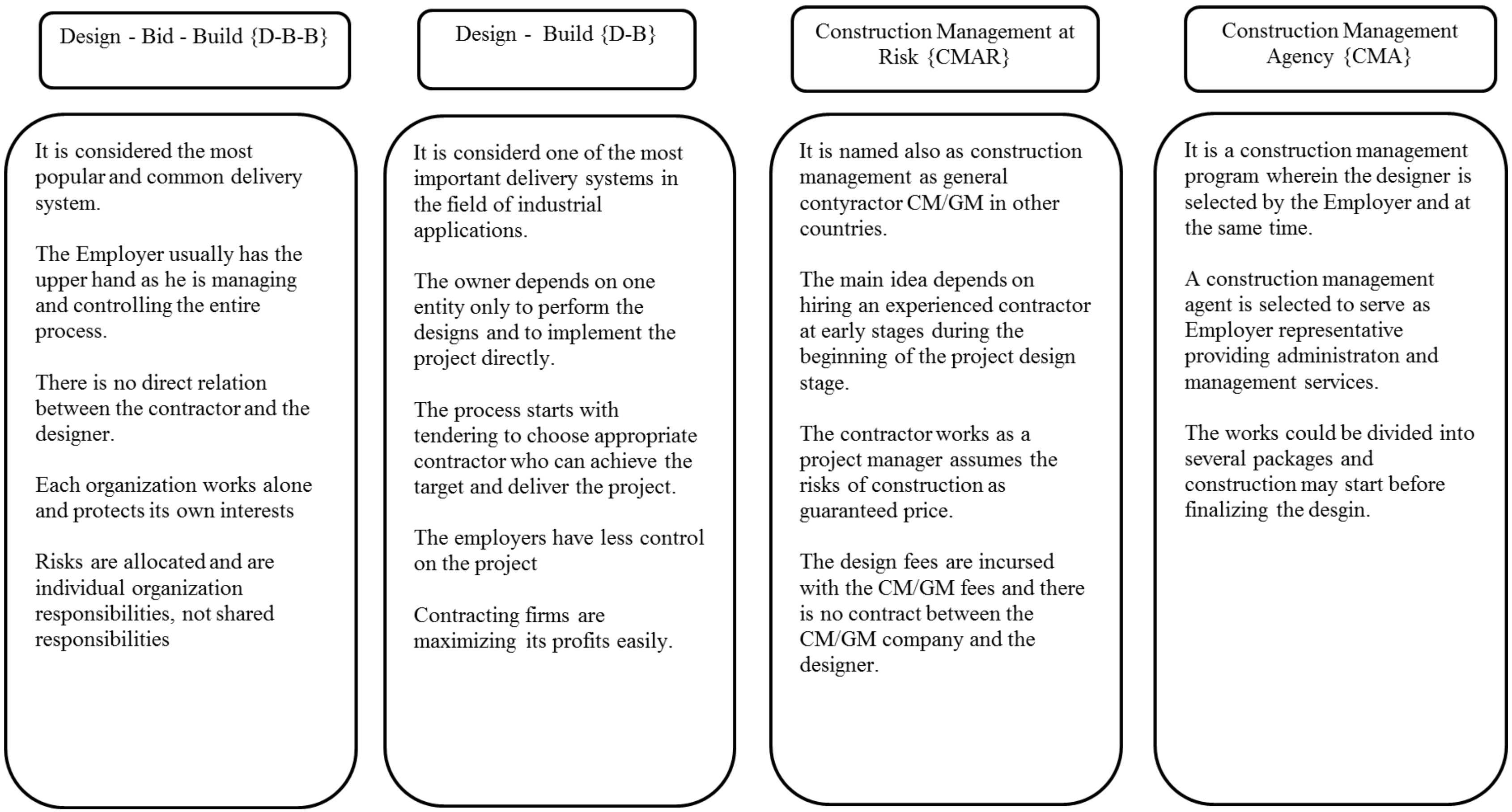

Fig. 1. Prevalent PDS [3]

2.2 An Overview of IPD

IPD is the recent arrow added to an owner's quiver of PDS from which to choose when embarking upon a capital facilities project. IPD has been regarded as a viable solution to the industry's low production and inefficiencies that are still prevalent today [6, 9]. IPD is a "project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction" [10]. IPD is a method of project delivery distinguished by having owners to sign a multi-party contract with the designer, contractor, and other key team members as part of "a collaborative process and a relational contract." [6, 11, and 12], several projects were implemented in USA using IPD such as: Cathedral Hill Hospital, Autodesk Inc., SpawGlass Austin Regional Office, and St. Clare Health Center [6], the main idea of IPD as collaborative PDS is illustrated in Fig. 2 below.

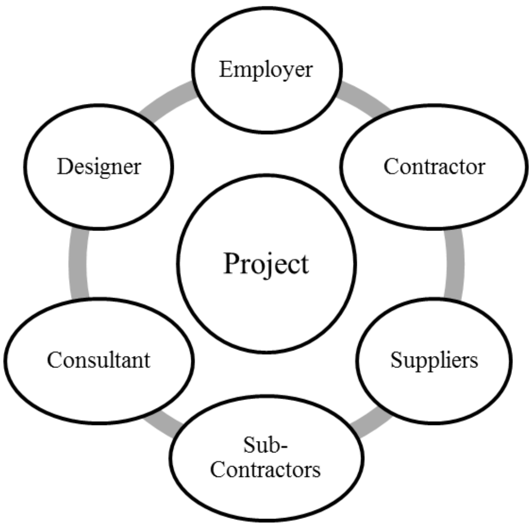

Fig. 2. Concept of IPD [13].

2.3 Key Principles of IPD

The IPD has its own characteristics and twelve key principles [12, 14] that could be summarized in Table 1 as follows:

Table 1. Summary of Key Principles of IPD.

2.3.1 Multi-party agreement	**2.3.2 Key participants bound together as equals**	**2.3.3 Early involvement of key participants**
It includes multiple organizations {e.g. owners, architects, engineers, contractors, construction managers, major sub-consultants and subcontractors, and other organizations vital to the success of the project [13].	This equilibrium enhances the collaboration principle and supports consensus-based decisions by setting terms that promote collaboration between stakeholders [14].	The purpose of forming an integrated team early in the project is to take advantage of the assortment expertise in the design process to better understanding of probable proposition of design decisions [12, 13].
2.3.4 Intensified design	**2.3.5 Jointly developed project target Criteria**	**2.3.6 Shared financial risk and reward**
Paying some efforts to complete the design prior to construction allows greater opportunity for cost control and enhances the ability to achieve the project outcomes [15].	Carefully defining project performance criteria with the input support and buy-in of all key participants ensures maximum attention will be paid to the project in all dimensions deemed important [15].	Profit sharing offers a way to determine collectively the potential profit each contracting organization can obtain rather than each organization determining its own profit [13].
2.3.7 Liability waivers between key participants	**2.3.8 Fiscal transparency between key participants**	**2.3.9 Collaborative decision-making**
When project participants agree not to sue each other, they are forced to resolve their problems rather than blaming each other [15].	This principle enhances the relationship between parties and assists to control the financial issues of the project and keep eye on the contingencies of the project [15].	This concept requires that all the participants should work together to issue the important decisions and encourage joint accountability, as such project teams rather than managers can make decisions [15].
2.3.10 Mutual respect and trust	**2.3.11 Willingness to Collaborate**	**2.3.12 Open communication**
Nurturing a positive environment requires deep appreciation for the motivations of all project participants [12, 14].	It is important to nurture an environment that supports and encourages participants to choose to collaborate [14].	Collaboration requires open, honest communication: Sharing ideas or opinions, make opportunities for innovation [12, 14].

2.4 PDS and Construction Risks

As annotated in literature above, the PDS is one of the most important aspects of the construction projects because it's used to build the contractual agreement which in its turn is the most enforceable documents in the project shaping the risk allocation between parties. Contractual terms have a significant influence on risks carried by each party and, therefore on the cost, quality, and duration of the project [16].

Risk is the prominent criterion that will determine the selection of PDS. From the perspective of risk management, selecting an appropriate PDS involves the assessment of many risk factors. Therefore, the selection can lower the risk for Employers and improve the possibility of success for the projects [17].

Assessing the construction risks and corresponding PDS for DBB and DB was developed [17]. While some alternative approaches to support the decision of choosing the PDS in construction projects were presented [18]. But in the meantime, there is no specific study to measure the influence of the IPD on reducing the risk magnitude in construction projects in Egypt. As such; this paper will focus on generating an updated list of construction risks and on measuring the anticipated reduction of risk magnitude / index under the assumption of applying the twelve principles of IPD in construction of building projects in Egypt.

2.4.1 Consolidated list of construction risks

Several researches of construction risks in Egypt and worldwide were reviewed [19-27] in order to generate a consolidated list of construction risks based on Egyptian practitioners' perspective. A group of {10} experts were selected to discuss the generated list before distributing it through a questionnaire survey. It was taken into consideration that experts' background are different to guarantee the diversity of their input and the years of experience are between 10 to 25 years to guarantee the stability of decision and proper judgment. Table 2 shows the list of experts who contributed in the development of the risks' list and questionnaire survey.

Table 2. List of Experts.

No.	Expert Position	Experience	Organization
1	CEO, Owner, PhD, FCIArb	25 Years	Consultant firm
2	Contracts Director, PhD, LLM, FCIArb	20 Years	Int. consultancy firm
3	Sr. Contracts Mgr., MSc, MRICS, MCIArb	18 Years	Int. consultancy firm
4	Contracts Manager, MSc, LLM, FCIArb	15 Years	Int. consultancy firm
5	Sr. Construction Manager, LLM, MBA	25 Years	Int. consultancy firm
6	Sr. Controls Manager, MRICS	25 Years	Int. Contracting firm
7	Sr. Claims and Contracts Manager, MRICS	20 Years	Contracting firm
8	Sr. Planning Manager	20 Years	Contracting firm
9	Sr. BIM Manager	10 Years	Contracting firm
10	Sr. HSE Manager	25 Years	Contracting firm

The resulted list of risks was categorized into eight major categories {Design risks, Political risks, Financial and cost risks, Nature – climate- force majeure, HSE, Construction risks, Management risks, and Contractual risks} with total of {57} risk factors as shown in Table 3.

2.5 Point of Departure

The IPD mainly depends on collaboration and proper alliancing between parties which could be a solution overcoming drawbacks of the traditional PDS. Several researches and dissertations worldwide were produced studying the IPD system. But neither of these studies tried to study the Egyptian market, and to measure the improvements that could be anticipated by utilization of the IPD. While the Egyptian market is starving for innovation in all fields of construction; it would be beneficial to investigate the ability of the Egyptian construction industry to implement IPD and to measure the anticipated risk reduction that may occur in construction of Building projects quantitatively. Achieving this target would provide insights and assistance to improve the construction environment in Egypt.

Table 3. Consolidated List of Construction Risks.

	Risk Groups		Risk Groups
A	**Design risks**	**E**	**Health and Safety (Continued)**
1	Incorrect project brief	29	Fire
2	Scope vagueness	30	Unsafe / Unsecured roads
3	Surveying mistakes	31	Theft and robbery
4	Design mistakes / errors	**F**	**Construction Risks**
5	Complexity of design	32	Late giving possession of site
6	Inconsistency of design with local regulations	33	Incorrect setting out data given by employer
7	Stakeholders request late design changes	34	Occupation of work site by the Employer
8	Prolonged design process / delayed technical instructions	35	Bad quality of works / defective works
9	Discrepancies between drawings and other documents i.e. BOQ, Specifications...etc.	36	Unforeseeable physical conditions
10	Difficulties due to non- utilization of BIM model (e.g. waste, rework, conflict, presentation…etc.)	37	Mismanagement of site layout
B	**Political risks**	38	Improper construction methods and material waste
11	Political instability	39	Resources unavailability
12	Corruption and bribery	40	Construction cost overruns
13	Delay in approval due to bureaucracy of regulatory bodies and Interference by authorities	41	Shortage of approved construction drawings
14	Unstable Governmental policies	42	Shortage of supply of water, gas, and electricity
C	**Financial and Cost risks**	43	Subcontractor's low credibility
15	Currency / Interest Rate Fluctuation	44	Variation orders for different reasons i.e. site conditions
16	Market inflation	**G**	**Management Risks**
17	Employer's Bankruptcy / lack of financial arrangements	45	Poor coordination / communication between key participants
18	Change in economic policies and tax systems	46	Priorities change on existing program
19	Improper budgeting & contingencies	47	Inconsistent cost, time, and quality objectives
20	Change of energy price / lack of fuel	48	Loss of venture and partnership
21	Delayed Payments	49	Incompetence of project management team
22	Import/export restrictions	50	Problems associated with cultural differences
D	**Nature, Climatic Risks , and Force Majeure**	51	Undefined authority of key participants
23	Earthquake	**H**	**Contractual Risks**
24	Flood, Landslide, Hurricane, Tornado	52	Breach in Contract
25	Weather conditions e.g. humidity, precipitation	53	Incomplete / unbalanced contract terms
26	Terrorism, Strike, lockout, lawlessness, civil disorder, War, Hostilities	54	Dispute about Intellectual property rights
E	**Health and Safety**	55	Termination by employer for convenience
27	Accident during construction or operation	56	Improper dispute resolution mechanism
28	Non-compliance of HSE policies and safety regulations on site	57	Third parties interference

2.6 Objectives of Research

a) Study the IPD comprehensively focusing on its key principles to make Egyptian practitioners aware of its characteristics.
b) Define the relative importance index {RII} of each key principle sorted / ranked according to its importance based on Egyptian practitioners' feedback.
c) Generate an updated list of construction risks based on the previous researches and experts' determination and assume relevant ranking of these risks (based on risk index).
d) Explore the influence of using IPD on construction risks by measuring the anticipated risk reduction, quantitatively, under the assumption of applying the IPD principles. This process could facilitate analysis of risks' evaluation and would be considered a decision support to enhance using IPD in Egypt.

2.7 Methodology

In order to achieve the research objectives, a literature review was conducted to explore the IPD principles and to generate an updated list of construction risks. Then; a questionnaire survey was designed to develop scoring scale for the IPD twelve principles by measuring the Relative Importance Index {RII} for each of these principles based on participants' input.

Interviews were conducted with participants and an orientation of IPD was provided. Subsequently; participants were requested to provide the anticipated risk reduction of each individual risk under the assumption of applying IPD system in construction projects in Egypt. The risk reduction was calculated using SPSS while reliability and stability of acquired results were statistically tested and accepted.

2.7.1 Scoring and ranking system

Five Likert scale was used in most of the questions of the questionnaire to sort the principles of IPD and to sort the construction risks without assuming application of IPD and sorting risks again to calculate anticipated reduction of risk magnitude under the assumption of applying IPD.

RII method was adopted based on respondents' feedback; this method utilizes the following equation [28]:

$$RII = \Sigma W / A \times N \tag{1}$$

Where: RII: Relative Importance Index, W: weight given to each factor by the respondents and ranges from 1 to 5, A: the highest weight = 5, and N: total number of respondents.

2.7.2 Research limitations

Some limitations were applied to this research in order to get maximum benefits of this study and avoid redundant results. These limitations or restrictions are:

1- This research and data collection is limited to construction industry in Egypt.
2- Research is limited to grade 1, 2, and 3 Contractors, according to the classification of Egyptian Federation for Construction & Building Contractors EFCBC.
3- Research is limited to Multi-disciplinary consultant offices according to the classification of Egyptian Engineers Syndicate.
4- Research is limited to all kinds of building projects and covering all trades such as civil, Arch, and MEP while excluding the infrastructure or roads projects because of its different nature and special conditions.

2.8 Sample Determination and Sample size

The size of sample was determined using statistical principle following the equations [28]:

$$n_o = (p \times q) / V^2 \tag{2}$$

$$n = n_o / [1 + (n_o / N)] \tag{3}$$

Where: n_o: First estimate of sample size, P: The proportion of the characteristic being measured in the target population, q: Complement of 'p' or (1-p), V: the maximum standard error allowed (will be considered as 10%), N: the population size, and n: the sample size.

For the purpose of getting maximum sample size and obtaining accurate results reflecting the respondents' real understanding of the IPD and its anticipated influence to reduce risks in the Egyptian Construction Industry; it was decided to consider P as 0.5 and q as 0.5 also, this will maximize the sample size to be 25 participants relevant to each different entity. As such; the minimum numbers of questionnaire forms would be 75 forms divided equally between Employers, Consultants, and Contractors.

An approximate number of 350 forms were distributed using all means of communications such as email, and face to face interviews. Only 132 forms were collected back, so the percentage of participation is about 37.71% which is considered acceptable. Table 4 illustrates the minimum sample size of each type of entities versus the real collected number of forms corresponding to each category.

Table 4. Minimum Sample Size Vs Collected Sample Size

No.	Respondent Category	Min. Sample Size	Collected Samples
1	Contractors	25	57
2	Consultants	25	50
3	Employers	25	25
	Total	75	132

2.9 Results and Analysis

The questionnaire was collected and analyzed using the {SPSS} suit and the main analyzed results are shown as following:

2.9.1 Knowledge Level of IPD

Figure 3 Illustrates that 40.91 % of respondent have basic knowledge about IPD which was surprising to the researcher as this system is not commonly used in Egypt. It's also shown in Fig. 3 that 38.64% of respondents have never heard about this system before, while 13.64% have theoretically studied it without using it in real projects and only 6.82% have used it in their projects.

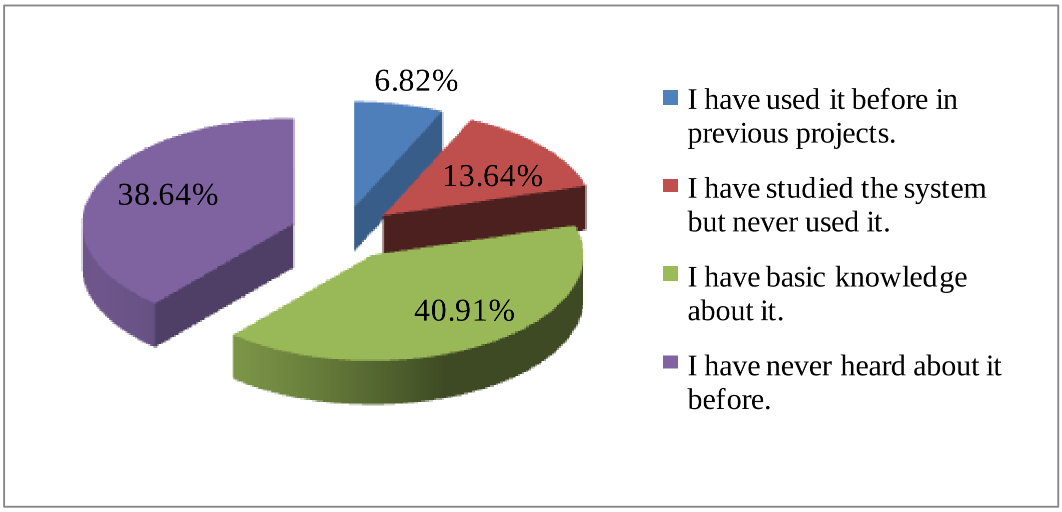

Fig. 3. Respondents' knowledge level of IPD.

2.9.2 Pervasiveness of different PDS in Egypt

According to the collected data in Table 5; the traditional system {DBB} is the commonly used system in Egypt while the Design-Build {DB} is ranked as the second utilized system. Other systems such as construction management agency {CMA} and construction manager at risk {CMGC} are not popular in Egypt while the IPD is not practically used.

Table 5. Pervasiveness of PDS.

No.	Descriptive Statistics	Mean	Std. Dev.	RII	Rank
1	Traditional system {DBB}	4.57	0.89	91.36	1
2	Design-Build {DB}	3.02	1.04	60.45	2
3	Construction Manager at risk or {CMGC}	1.61	0.89	32.27	4
4	Construction Management Agency {CMA}	2.34	1.45	46.82	3
5	Integrated Project Delivery {IPD}	1.18	0.62	23.64	5

2.9.3 Relative importance of IPD principles

As enlightened in the literature review of this research that IPD system has twelve main principles forming the system. Table 6 shows the RII of each principle as calculated from Egyptian practitioners' feedback; it's revealed that {P3- Early Involvement of Key Participants} is the most important principle. This emphasizes the understanding of participants of the importance of collaboration in early stages of the project and reflects that Egyptian professionals are eager to work together in earlier stages of the project. Table 6 also shows that {P6- Shared Financial Risk and Reward Based on Project Outcome} is considered as the 2nd ranked important principle. This highlights the necessity of sharing financial risks and rewards between all key participants as a logical result of good communication and integration between parties.

Table 6. RII of IPD Principles.

No.	Description / IPD Principle	Mean	Std. Dev.	RII	Rank
P3	Early Involvement of Key Participants	4.39	0.78	87.73	1
P6	Shared Financial Risk & Reward Based on Project Outcome	4.14	0.85	82.73	2
P4	Intensified Design	4.07	0.84	81.36	3
P12	Open Communications	4.05	0.91	80.91	4
P5	Jointly Developed Project Target Criteria	3.89	0.89	77.73	5
P8	Fiscal Transparency Between Key Participants	3.89	1.03	77.73	6
P11	Willingness to Collaborate	3.89	0.96	77.73	7
P1	Multi-party Agreement	3.86	1.02	77.27	8
P9	Collaborative Decision Making	3.86	0.87	77.27	9
P10	Mutual Respect and Trust	3.84	1.09	76.82	10
P2	Key Participants Bound Together as Equals	3.52	0.84	70.45	11
P7	Liability Waiver Between Key Participants	3.52	1.24	70.45	12

A principle such as {P2-Key Participants Bound Together as Equals} was ranked as 11th in this list; which gives better understanding of how Egyptian culture interacts with the IPD system as a whole, but confirms the fact that Egyptian professionals are not yet accepting the complete equity between all parties and are still believe that parties should not be equal in their contractual positions.

Same line of thinking was observed when interpreting that RII of {P7- liability waivers between key participants} was ranked at the bottom of Table 6. This sheds light on Egyptian conservative mentality and the old theory which pushes each party to be keen for reserving its rights only without accepting the concept of waiving claims between key participants of the project.

The middle section of Table 6 contains different principles such as {P12 –Open Communications} and {P8-Fiscal Transparency between Key Participants} which when analyzed gives an indicator that the Egyptian professionals in construction industry accept that financial issues should be transparently discussed in order to facilitate the works.

The 8th rank is {P1 –Multi-party Agreement}, this emphasizes the fact that the Egyptian practitioners still don't give much attention to this principle and are still believe that having a multi-party contract form is still not crucial for achieving appropriate collaboration.

2.9.4 Anticipated risk reduction under assumption of applying IPD

In order to calculate the anticipated risk reduction {to achieve one of the research objectives}, the participants were requested to share their thoughts about the risk probability and impact in a five Likert scale assuming normal conditions ,without assumption of applying IPD, {the researcher calculated risk index "Mean" using SPSS}. Then the participants were requested to repeat the process again under the assumption of applying the IPD and its key principles. It's worthy to mention that the participants received, by the researcher, a comprehensive orientation, illustrative discussions, and several informational publications discussing the IPD and its key principles to overcome any potential vagueness or misconception before expressing their feedback regarding the anticipated risk index reduction.

Remarkable anticipated risk reduction has been noticed due to the influence of IPD principles as shown in Table 7. It's gleaming that the top {10} risks in terms of risk reduction are technical related risks and other risks related to collaboration between parties such as: "scope vagueness", "poor coordination between key participants", "discrepancies between drawings and other document", "stakeholder request late design change", "design mistakes" and, "inconsistent cost, time, and quality objectives".

It's noteworthy to mention that construction related risks and contractual related risks faced high to moderate percentages of risk reduction score such as: "Incorrect setting out data given by employer", "late giving possession of site", "subcontractor's low credibility", "Improper construction methods and material waste", "bad quality of works, Incomplete/unbalanced contract terms", "Improper dispute resolution mechanism", and "breach of contract", These risk reduction improvements indicate that the IPD system has a positive influence on the construction process itself starting from the design stage, contractual stage, and construction stage.

As for the economic/political related risks; a moderate to low risk reduction was calculated such as: "market inflation", "political instability", "changes in economic policies and tax systems", "import/export restrictions", and "change in energy price/lack of fuel".

Table 7. Anticipated Risk Reduction before and after Assumption of IPD.

Code	Risk Description	Before IPD Assumption {Risk Index}		After IPD Assumption {Risk Index}		% Anticipated Risk Reduction	T-Test	Sig.
		Mean	St.D	Mean	St.D			
A2	Scope vagueness	13.41	6.01	5.39	3.91	-59.81	15.05	0.00
G45	Poor coordination / communication between key participants	14.57	5.82	5.91	4.89	-59.44	11.54	0.00
A9	Discrepancies between drawings, other documents i.e. BOQ …etc	15.36	5.87	6.43	4.03	-58.14	14.26	0.00
A7	Stakeholders request late design changes	17.59	6.18	7.66	4.04	-56.45	15.89	0.00
A4	Design mistakes / errors	13.68	5.24	6.02	3.7	-55.99	15.48	0.00
A1	Incorrect project brief	9.93	5.56	4.5	3.08	-54.68	11.99	0.00
G47	Inconsistent cost, time, and quality objectives	12.98	5.65	6.36	4.9	-51	10.31	0.00
A8	Prolonged design process / delayed technical instructions	14.84	6.07	7.34	4.46	-50.54	11.03	0.00
G41	Shortage of approved construction drawings	12.95	4.51	6.75	4.84	-47.88	10.8	0.00
A10	Difficulties due to non- utilization of BIM model {e.g. waste, rework, conflict, presentation…etc.}	10.73	6.54	5.61	3.79	-47.72	8.56	0.00
H53	Incomplete / unbalanced contract terms	14.52	6.74	7.61	6.01	-47.59	9.28	0.00
G46	Priorities change on existing program	12.89	5.69	6.86	4.91	-46.78	8.96	0.00
G44	Variation orders for different reasons i.e. site conditions	15.84	5.65	8.45	5.11	-46.65	13.31	0.00

Table 7. Anticipated Risk Reduction before and after Assumption of IPD. (Cont.)

F33	Incorrect setting out data given by employer	10.36	4.95	5.59	4.05	-46.04	10.98	0.00
A6	Inconsistency of design with local regulations	10.68	5.58	5.93	2.79	-44.48	9.75	0.00
F32	Late giving possession of site	12.18	5.3	6.86	4.15	-43.68	10.15	0.00
F40	Construction cost overruns	16.5	5	9.86	5.06	-40.24	12.42	0.00
F43	Subcontractor's low credibility	11.23	5.86	6.89	3.41	-38.65	7.75	0.00
H56	Improper dispute resolution mechanism	12.77	4.91	7.91	6.45	-38.06	7.12	0.00
F38	Improper construction methods and material waste	10.75	4.78	6.75	3.75	-37.21	8.62	0.00
C19	Improper budgeting & contingencies	14.11	5.78	8.93	5.3	-36.71	9.65	0.00
F37	Mismanagement of site layout	9.89	4.59	6.3	3.98	-36.3	8.12	0.00
H52	Breach in Contract	12.91	5.52	8.25	6.15	-36.1	6.76	0.00
F35	Bad quality of works / defective works	13.27	4.79	8.64	4.22	-34.89	8.4	0.00
G49	Incompetence of project management team	12.48	5.05	8.16	5.14	-34.62	7.35	0.00
A5	Complexity of design	10.39	4.87	6.8	3.42	-34.55	7.19	0.00
G51	Undefined authority of key participants	11.16	5.53	7.43	6.28	-33.42	6.56	0.00
A3	Surveying mistakes	9.82	4.73	6.55	3.93	-33.3	8.07	0.00
G48	Loss of venture and partnership	9.89	5.3	6.68	4.65	-32.46	4.54	0.00
E27	Accident during construction or operation	11.07	5.49	7.61	3.55	-31.26	7.31	0.00
H55	Termination by employer for convenience	9.27	4.55	6.77	5.21	-26.97	4.55	0.00
C21	Delayed Payments	15.86	5.77	11.66	6.49	-26.48	7.87	0.00
F34	Occupation of work site by the Employer	8.86	4.38	6.55	4.17	-26.07	6.18	0.00
E28	Non-compliance of HSE policies and safety regulations on site	11.86	5.93	8.86	4.92	-25.3	6.38	0.00
C17	Employer's Bankruptcy / lack of financial arrangements	12.09	5.41	9.07	4.8	-24.98	6.41	0.00
C15	Currency / Interest Rate Fluctuation	19.61	6.14	14.84	6.38	-24.32	8.67	0.00
F36	Unforeseeable physical conditions	10.61	5.75	8.09	4.41	-23.75	6.73	0.00
G50	Problems associated with cultural differences	7.66	4.34	5.86	4	-23.5	3.56	0.00
H57	Third parties interference	9.07	5.18	6.95	4.96	-23.37	3.39	0.00
E29	Fire	10.98	5.62	8.45	3.59	-23.04	5.29	0.00
B13	Delay in approval due to bureaucracy of regulatory bodies and Interference by authorities	17	5.88	13.2	6.64	-22.35	7.16	0.00

Table 7. Anticipated Risk Reduction before and after Assumption of IPD. (Cont.)

C16	Market inflation	18.59	5.97	14.57	6.05	-21.62	7.39	0.00
F39	Resources unavailability	11.16	5.3	8.8	5.24	-21.15	6.19	0.00
B11	Political instability	13.98	6.62	11.48	6.18	-17.88	5.43	0.00
D25	Weather conditions e.g. humidity, precipitation	6.32	4.58	5.2	3.02	-17.72	4.01	0.00
C18	Change in economic policies and tax systems	14.91	6.54	12.36	5.75	-17.1	6.1	0.00
C22	Import/export restrictions	13.14	5.5	10.93	5.42	-16.82	5.17	0.00
B12	Corruption and bribery	12.25	6.1	10.23	6.03	-16.49	3.61	0.00
F42	Shortage of supply of water, gas, and electricity	8.43	3.91	7.05	3.64	-16.37	4.59	0.00
E30	Unsafe / Unsecured roads	8.55	4.95	7.2	3.85	-15.79	3.34	0.00
C20	Change of energy price / lack of fuel	15.61	6.23	13.2	5.95	-15.44	4.73	0.00
H54	Dispute about Intellectual property rights	6.45	4.24	5.48	4.77	-15.04	1.78	0.05
D23	Earthquake	6.23	4.39	5.34	3.23	-14.29	2.48	0.01
B14	Unstable Governmental policies	14	6.48	12.3	6.83	-12.14	3.7	0.00
D26	Terrorism, Strike, lockout, lawlessness, civil disorder, War, Hostilities	10.32	5.99	9.2	5.5	-10.85	2.92	0.00
D24	Flood, Landslide, Hurricane, Tornado	5.09	4.14	4.77	3.23	-6.29	0.85	0.40
E31	Theft and robbery	7.43	5.01	7.11	3.96	-4.31	0.92	0.05

2.10 Questionnaire Reliability Check

Reliability is a measure of internal consistency between different items of the same construct. When a multiple-item scale is provided to respondents and yield similar score every time even if it is completed at two different points in time, this is a reflection of internal consistency. Therefore, it can be said that reliability can be estimated in terms of average inter-item correlation, average item-to-total correlation, or more commonly, Cronbach’s alpha [29]. In this study, reliability of each scale has been tested through Cronbach’s alpha to identify the internal consistency of the scale. The following table demonstrates Reliability Analysis for Research Variables in the questionnaire:

Table 8. Reliability Analysis for Questionnaire Variables.

No.	Variables	Cronbach's Alpha	No. of Statements
1	Aggregated list of construction risks before IPD effect	.946	57
2	Principles of IPD	.874	12
3	Aggregated list of construction risks after adding effect of IPD	.936	57

The variables measure also the principles of IPD and the aggregated list of construction risks after adding effect of IPD application. The coefficient of Cronbach's Alpha varies from 0.874, 0.936, and to 0.946 as indicated in Table 8. The coefficient of consistency takes values ranging between zero and the right one, if there was no data on the stability of the value of this parameter equal to zero, and vice versa, where if there is a complete firming be the parameter value equal to the correct one. And therefore the closer the value of reliability coefficient of the correct one indicates that the Stability is high.

3. FINDINGS

Statistical analysis revealed that 6.82% of participants have practically implemented the IPD, while 13.64 % of participants have theoretically studied the system without working with it in their projects and 40.91% of participants have basic knowledge about the system. As such a total of 61.36% of participants have different previous levels of knowledge about the IPD before participation. 38.64% of participants have no previous knowledge of IPD. It’s worthy to mention that all participants have received an orientation to ensure full understanding of IPD before participation in the questionnaire survey.

Based on the conducted analysis with its limitations and assumptions, the findings indicate that IPD principles have different RII as listed in this paper. “Early involvement of key participants” is the most important key principle followed by “Sharing the financial risks and rewards”, this reflects good understanding of IPD importance and the necessity of keeping the financial balance between parties. This balance is considered the keystone that inspires project parties to utilize IPD widely.

Based on statistical analysis, significant anticipated risk reduction was recognized for “design” and “management” risks while moderate anticipated reduction was noticeable for “construction” and “contractual” risks and slight anticipated reduction was found for “economic” and “political” risks.

4. CONCLUSION

Despite that the conducted risk reduction is based on participants’ anticipation, it could be accepted as the research is introducing a new system which is not applied widely in the country especially that results were consistent based on the statistical tests and participants’ awareness of the IPD and its key principles.

Based on conducted statistical results; IPD is a promising system that could resolve the inherited problems of other currently used PDS. Therefore; it’s recommended to be widely applied in Egypt as a tool of risk reduction in construction of building projects.

Applying IPD would contribute in reducing friction between contract parties and would also enhance the trust level in the Egyptian construction market and could be considered a source of attraction to international corporations to invest in the construction field in Egypt because Egyptian market has the ability to cope with such recent techniques.

This study is an attempt to present the potential benefits of applying the IPD in Egypt as it sheds light on the significant anticipated risk reduction under the assumption of applying IPD principles for technical, construction, contractual, and economic related risks. This reduction would contribute in a notable cost savings especially in the field of risk management in building projects in Egypt.

IPD still remains in many ways a “black box” for Egyptian Construction Sector. This research aimed to uncover some of its features for the purpose of highlighting the importance and advantages of utilizing IPD. However, due to limitations set forth in this study; further researches are encouraged to explore different mechanisms in more detail and measure their impact on ongoing life projects.

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النظام التكاملى لتسليم المشروعات وعلاقته بتقليل المخاطر فى مشروعات التشييد فى مصر

يدرس البحث أثر النظام التكاملى لتسليم المشروعات على مخاطر مشروعات التشييد فى مصر وتعريف النظم المختلفة لتسليم المشروعات وعرض مشكلاتها مع إقتراح العمل بالنظام التكاملى لتسليم المشروعات كأحد الحلول للتغلب على هذه المشكلات، وقد تم تطوير قائمة بمخاطر المشروعات وتصميم إستبيان لقياس الإنخفاض الرقمى المتوقع فى هذه المخاطر بافتراض تنفيذ المشروعات تحت مظلة النظام التكاملى المشار إليه، وقد أظهر التحليل الاحصائى للنتائج إنخفاضا ملحوظا كما هو متوقع فى المخاطرالمتعلقة بالتصميم وإدارة المشروع إنخفاضا متوسطا متوقعا فى المخاطر الخاصة بالتنفيذ والتعاقدات كما تلاحظ وجود خفض متوقع طفيف فى المخاطر السياسية والاقتصادية، كما تناول البحث كذلك خصائص النظام التكاملى وترتيبها طبقا لوزنها النسبي لبيان اهميتها وإنتهى البحث إلى وجود فوائد محتملة وخفض فى المخاطر الخاصة بالمشروعات حال تطبيق هذا النظام فى مشروعات تشييد المبانى فى مصر.