

Identifying Issues in Applying Integrated Project Delivery to Domestic Nuclear Power Plant Construction Projects

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1. Introduction

Integrated Project Delivery (IPD) is defined as that people, systems, business structures, and practices of key stakeholders are incorporated into a single-team, with a single process, which executes a project in a way of optimizing the project's outcome, increasing values delivered to the end user, reducing waste, and maximizing efficiency throughout the phases of engineering to construction [1].

The researcher had carried out literature review in terms of IPD to identify major characteristics of IPD which are presented in the following section and had compared such characteristics against peculiarities of nuclear power plant (NPP) construction projects in order to shed light on obstacles in possible application of IPD method to domestic NPP construction projects in the coming days.

2. Methods and Results

2.1. Identifying Major Characteristics of IPD

The researcher carried out literature review on IPD, starting from papers from American Institute of Architects (AIA) to several domestic and international transactions and journals on the subject. Keeping in mind that the definition of IPD currently evolves [2], the following major characteristics of IPD were identified.

2.1.1. Sharing Risk and Reward via Multi-Party Agreement

In IPD, stakeholders, based on a balanced contract, become one body, sharing risk and reward.

In traditional project delivery methods, owners usually include contingency into their budget for projects in order to cover unexpected events; rather than systematically analyzing the risk, owners typically multiply a certain percentage to compute contingency amount [3]. In IPD, however, each member waives his right to make claims and shares all risks together; instead of pursuing his own individual risk aversion, members of IPD project team aim for a common goal and make decisions best for the whole project [4].

In IPD, all key stakeholders are bound to a single contract signed even prior to the beginning of engineering works. Key stakeholders can include owner,

general contractor, designer, owner's engineer, subcontractors, and suppliers [2].

According to AIA, in IPD, project team at the project inception decides the project's target cost in accordance with the owner's business and the goal of the project, and as the project progresses, the team makes necessary decisions by continually re-estimating the cost at completion. By establishing a balanced risk and reward incentive structure through a multi-party agreement, owner/designer/contractor prosper together or suffer together [5].

Therefore, in IPD where one party's uncertainty becomes the other parties' risk and one party's success equals the other parties' profit, there would be no room for the blame culture.

2.1.2. Early Engagement by Integrated Project Team

In IPD, from the start of a project, an integrated team is formed and constituents of the integrated team provide input to each other, taking a front-loaded approach.

In traditional project delivery methods such Design-Bid-Build, a general contractor joins a project after the completion of engineering works, whereas in IPD key stakeholders including a generator contractor participate in an integrated project team even before the start of the design process [2]. In IPD, thanks to owner, designer, contractor all participating in the project from the early engineering stage, designers are able to reflect constructability into their outcome, and this would reduce frequency of re-engineering works, design changes in the later stage, compared to traditional project delivery methods [6]. IPD allows engineering works to be reviewed to a higher level prior to construction activities; this enables effective construction works and shortens construction duration [7]. During design stage, constructor can provide professional advices on construction methods and procedures and can participate in assessing site condition, resulting in more inclusive and realistic budget estimation [3]. Since IPD method begins at the very inception of a project, IPD project team can experiment various concepts and alternatives from the early stage and can continue to make decisions best for the project [5].

As stated above, by adopting such front-loaded approach by forming an integrated team from the start of a project, in IPD, time-and-money-consuming

reworks occurring later in a project can be minimized or avoided.

2.1.3. Abridged Decision Making Process thanks to Direct Communication

Little sense of liability can lead to enhanced communication among constituents of an integrated project team and such dynamics can bring in innovation to the project. By co-locating members from the owner side and the contractor side in a same place, the team become free from hierarchical culture. Time and resources consumed in approval process can be reduced dramatically [4]. In IPD, project-related information is shared among the owner, architect, engineer, and contractor, etc. Decisions on the project are made in early stages [7]. In IPD, for actual project scope, designers and constructors work together and can add clarity to construction documents prepared for the end user so as to allow the end user have better understanding of the actual project [3]. According to AIA, personal and face-to-face meetings are more effective than any other forms of meeting; therefore, co-location by which project team members work in a same place is a very effective tool for team communication. Delegates from the owner side are required to continually provide timely feedback [5].

In IPD, an integrated team can work face-to-face among its members in one location, can have open communication, being freed from locating the liability to others, and can make decisions on time.

2.2. *Highlighting Major Peculiarities of Domestic NPP Construction Projects*

NPP construction usually takes long duration and is implemented by various organizations from domestic and overseas. The followings are major peculiarities of building a typical NPP as per International Atomic Energy Agency [8].

2.2.1. Long Duration, Wide Scope of Activities by Various Entities

Experientially, it takes ten (10) to fifteen (15) years for a state to build its first NPP, counting from a policy decision to actual operation of the NPP. In construction stage, main contractor and architect-engineer mainly put effort, whereas utilities provide an independent project management team to supervise overall progress of construction activities. Main contractor has responsibility for engineering and construction. Should utilities have necessary competency, they take the burden of management and engineering effort.

Additionally, in case of domestic NPP construction projects, engineering, procurement, construction, commissioning activities are all packaged separately

and contracted independently. For Balance of Plant alone, there are typically 190 procurement packages.

2.2.2. Financing

Although advancement of reactor technology would contribute to decrease in capital cost, it seems investment cost for NPP project remains considerable higher than other alternatives. Thus, financing is the most critical restraint in implementing NPP project. Primary source of financing would be investors, owners, and operators; bond, domestic bank credit or national budget would be other sources.

2.2.3. Safety

Nuclear power plants have to achieve high-level standards of safety. Possibility of radioactive material leakage, of exposure to radiation, of loss of control of reactors is to be limited. If an event occurs, its consequences should be mitigated. Therefore, NPP technology are to be proven from the perspectives of scope of supply, licensing criteria, and operating experience. By strictly applying demonstrated licensibility, risk in safety can be reduced.

2.3. *Comparing Major Characteristics of IPD and Major Peculiarities of NPP Construction Projects*

By juxtaposing major characteristics of IPD method identified in Section 2.1 above and peculiarities of NPP construction highlighted in Section 2.2, the researcher was able to observe the following issues is applying IPD to domestic NPP construction projects.

First, whereas risk and reward are shared under one governing contact in IPD, a typical domestic NPP construction project is split into hundreds of packages then contracted separately. From the view point of IPD method, the researcher sees that the current set up encourages pursuing individual success by each stakeholder rather than fostering corporate endeavor to accomplish the overall success of the project itself.

Second, In IPD, key stakeholders join the concerned project in the early stage, and such early engagement allows the integrated team experiment multifarious concepts and alternatives, consider constructability into design, and estimate more inclusive and realistic project budget. However, in case of a typical domestic NPP construction project, it typically takes more than a decade from its inception to completion, and designer and constructor participate in the project following pre-project stage and project decision-making stage; therefore, the researcher sees that advantages which can be gained by IPD's early engagement including better constructible design and more accurate budget estimation which can lead to optimized financing are not fully exploited.

Third, in IPD, an integrated project team works in a same place, resolves issues through open and direct communication, and makes decisions in a real time. Also, such enhanced communication can lead to innovation. However, in case of domestic NPP construction projects, traditional owner-contractor hierarchical structure is a norm. Additionally, in a typical NPP project, technical safety is strongly emphasized and proveneness as well as demonstrated licensibility is more appreciated.

3. Conclusions

In this research, three (3) major characteristics of IPD were identified: 1) key stakeholders signing one balanced contract, forming de facto one body, sharing risk and reward 2) an integrated project team being formed in the early stage of a project and providing input to minimize time and cost loss from rework downstream 3) team members co-locating, having open and direct communication, making decisions on time, and pursuing the success of the project itself.

Peculiarities of typical NPP construction projects were highlighted as well. NPP construction usually takes long time (ten to fifteen years), needs higher capital cost than other alternatives, requires higher standard in technical safety.

The researcher identified heterogeneities in natures between the IPD method and NPP construction projects. The researcher sees that governmental, regulatory, private, and educational organizations in domestic NPP construction field should deepen their understanding of the IPD method and have a general consensus about benefits of IPD prior to adapting IPD into NPP construction projects.

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