COMPENSATION STRUCTURE AND CONTINGENCY ALLOCATION IN INTEGRATED PROJECT DELIVERY SYSTEMS

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ABSTRACT: Integrated Project Delivery (IPD) as a delivery method fully capitalizes on an integrated project team that takes advantage of the knowledge of all team members to maximize project outcomes. IPD is currently the highest form of collaboration available because all three core project stakeholders, owner, designer and contractor, are aligned to the same purpose. Compared with traditional project delivery approaches such as Design-Bid-Build (DBB), Design-Build (DB), and CM at-Risk, IPD is distinguished in that it eliminates the adversarial nature of the business by encouraging transparency, open communication, honesty and collaboration among all project stakeholders. The team appropriately shares the project risk and reward. Sharing reward is easy, while it is hard to fairly share a failure. So the compensation structure and the contingency in IPD are very different from those in traditional delivery methods and they are expected to encourage motivation, inspiration and creativity of all project stakeholders to achieve project success. This paper investigates the compensation structure in IPD and provides a method to determine the proper level of contingency allocation to reduce the risk of cost overrun. It also proposes a method in which contingency could be used as a functional monetary incentive when established to produce the desired level of collaboration in IPD. Based on the compensation structure scenario discovered, a probabilistic contingency calculation model was created by evaluating the random nature of changes and various risk drivers. The model can be used by the IPD team to forecast the probability of the cost overrun and equip the IPD team with confidence to really enjoy the benefits of collaborative team work.

Keywords: Integrated Project Delivery (IPD); Compensation Structure; Contingency Allocation; Monetary Motivation; Risk Analysis.

1. INTRODUCTION

Traditional project delivery methods include Design-Bid-Build (DBB), Design-Build (DB), and CM as Agent and CM at Risk (CM/A or CM@R) for public and private works. More and more professionals are frustrated with project outcomes and claim that projects often run over schedule and over budget [1]. The construction industry has been searching for effective project delivery methods to maximize project performance over the past decades [2]. The Architect, Engineer and Contractor (A/E/C) industry is fragmented, inefficient, and adversarial because each team is responsible for its own work and attempts to maximize their individual profit [1][3-4]. As a new delivery approach, Integrated Project Delivery (IPD), is also a new contractual arrangement that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste and rework, and maximize efficiency through all phases of design, fabrication and construction [5-6].

IPD stems from the Project Alliancing project in the United Kingdom and has been used most successfully in Australia [7]. In the United States, the Lean Construction Institute (LCI) began promoting collaborative project structures to support project collaboration in 1997 [7]. In 2004 and 2006, the Construction Users Roundtable (CURT) generated two whitepapers urging significant change throughout the construction process. American Institute of Architect (AIA) and Associated General Contractors of America (AGC) documents provide a theoretical framework and create a contract structure where the key participants include the owners, designers, contractors and significant trades [5-6][8] which support the advancement of IPD. Some research efforts have been conducted regarding the benefits and challenges [9-10], but the number of IPD projects are small [11-12] because many barriers are impeding the widespread adoption of IPD. Financial barriers are one of the critical types of barriers identified [4][10-11]. In 2010, Cohen [10] defined financial barriers as the challenges of selecting compensation and incentive structures commensurate to

the unique characteristics of the project and its participants. However, research on the topic since has been sparse.

This paper investigates the compensation structure in IPD and provides a method to determine the proper level of contingency allocation to reduce the risk of cost overrun. A probabilistic contingency calculation model was created by evaluating the random nature of changes and various risk drivers based on the compensation structure scenario discovered. The model can be used by the IPD team to forecast the confidence to prevent the cost overrun and equip the IPD team with the confidence to really enjoy the benefits from collaboration.

2. DIFFERENCES BETWEEN IPD AND TRADITIONAL DELIVERY METHODS

Compared to traditional delivery methods, IPD is changing the project delivery team structures from fragmented, hierarchical and controlled team arrangement to an integrated team entity; from a linear, distinct, segregated process to a concurrent and multi-level delivery process; from a policy of secrecy to an open exchange information and knowledge sharing, from individually managed risk modes to collectively managed and appropriately shared risk protocols. Traditional project delivery encourages unilateral effort by which each party allocates its own risk and transfers its risk to others; while IPD encourages multi-lateral open communication and collaboration. Thus, the essence of IPD is a deeply collaborative process with principles that are set forth to support the process.

There are fundamental differences between traditional delivery methods and IPD. The main critical differences are agreements and contracts, project team relationships and compensation structures.

2.1 Agreements and Contracts

Traditional construction contracts are adversarial in nature. The owner contracts with a CM/GC and a CM/GC contracts with subcontractors for different disciplines. Traditional contracts provide little incentive for subcontractors to collaborate or cooperate with each other, as each is driven by contract language to focus on completion of their own portion of the work. Matthews and Howell (2005) [9] point out four major systemic problems with the traditional contractual approach:

1. Good ideas are held back since the design lacks of field input.
2. Contracting inhibits coordination as well as discourages cooperation and innovation.
3. Subcontractors are not responsible for each other's work and unable to coordinate.
4. There is pressure for local optimization to maximize each party's profit.

IPD is a relational contracting approach; relational contracting enables the stakeholders to work together for mutual respect and mutual benefit. It also enables the stakeholders to reduce risk instead of shifting it to others, to achieve project success instead of optimizing individual interests.

Currently, there are five types of contracts being used for IPD projects - three sponsored by associations and two private agreements: AIA C191(three-party agreement); AIA C195(Single purpose Entity); ConsensusDOCS 300(three-party agreement); the IPD Agreement prepared by Hanson Bridgett LLP and the Integrated Form of Agreement (IFOA) used by Sutter Health and initially created by the construction group of McDonough Holland and Allen. The common use of AIA C191 and the CD300 provide the standard form contracts. Both use a single contract for three parties, the owner, the designer and the contractor, and leave the opportunity for the other party to be added to the board.

Before using any of the existing forms, the practitioner should compare the structure of the form to make sure it is a good match to the business agreement. IPD is designed to encourage collaboration, enhance communication and provide opportunities and incentives for creativity. It encourages behaviors that lead to exceptional project performance and value, which should be written in the contract articles by:

> "Remov(ing) impediments to and stimulate communication, collaboration and creativity Align participants to well-understood and agreed upon objectives; and Encourage and reward behavior that increases project value" [13].

2.2 Project Team Relationships

IPD principles include mutual trust and respect, sharing risk and reward, open communication, transparency, collaborative decision making and innovation among project stakeholders. All these principles are based on trust, and in turn. In turn, trust is gained from team members' relationships and commitments. From the management point of view, the basic attributes for a team to work effectively are: trust and confidence; consensus; commitment and collaboration; and open communication. The most important attribute is trust and confidence, since the rest of the attributes are based on trust and confidence, that is the primary base for the creation of a team.

Briscoe and Dainty conducted a study of supply chain integration in construction and found that the lack of trust among construction parties inhibited project teams from the collaboration necessary for an integrated project.

2.3 Compensation Structure

As a new business structure, IPD also ties compensation to achieving project objectives, which includes high quality, low waste through efficient team collaboration. Although languages vary, currently all IPD agreements embrace Risk and Reward sharing by setting a risk pool that is directly affected by project team performance. By sharing the same benefits pool, stakeholders are expected to become more concerned to optimize the whole project but not only their own part. Providing suggestions and assistance to other parties is

encouraged, which enables communication and collaboration meanwhile.

In IPD, not only the designer, but also the contractors and subcontractors input expertise into the design phase in order to derive maximum constructability, lower cost, and minimum construction schedule. The team collaborates with a BIM model, which allows the team designs focusing not only on the product but also on the construction process such as material supply, fabrication and logistics. This is a lean concept design and it is called Target Value Design (TVD). TVD is considered one of the most powerful tools in IPD [14]. Based on TVD, project Target Cost (PTC) is developed by project integrated team within the value that project team commit. In PTC, key factors that need consideration include direct cost, contingency allocation, team profit, and the portion that team will share the benefits. PTC is different from Guaranteed Maximum Price (GMP) in traditional delivery methods. GMP is a monetary cap on a cost contract, as savings from cost under-run will return to owner and cost overruns are responsible by contractor. Since contractor does not get involved in the design phase, contractor and subcontractor are lack of full understanding of the project scope. Actually in GMP, there are negative incentives to stakeholders [14].

While PTC is developed by collaborative decision making, contractor and subcontractors are providing expertise and ownership to TVD. Stakeholders hold more confidence on accomplishment. However, still different opinions from each part's prospective on the compensation structure since owner believes that PTC should be lower than traditional delivery; and contractors want to PTC is higher enough that they can enjoy sharing the reward from the collaboration and providing expertise during the lifecycle of the project. Construction is full of uncertainties and a one-time product. There is not a guarantee that cost will under run if the project uses IPD. For cost saving, it is easy and happy to share among the project stakeholders; while, it will be hard if the cost over runs.

3. RESEARCH METHODOLOGY

This research is conducted in order to investigate the compensation structure in IPD which are promoting IPD project team collaboration and coordination. The authors and the research team wanted to address the following questions:

1. What are the proper compensation structures in IPD?
2. What are advantages and disadvantages of each compensation scenario?
3. Can contingency act as incentive in IPD compensation?
4. What is the right level for contingency estimation in order to promote team work?

The investigation of the IPD compensation structure focuses on the challenges that it is expected to promote IPD project team collaboration and coordination. As contingency is an important part of the compensation, its functional monetary incentive protocol was investigated. A probabilistic contingency calculation model was then created by evaluating the random nature of changes and various risk drivers.

4. IPD COMPENSATION STRUCTURE AND CONTINGENCY ALLOCATION

Compensation becomes critical in IPD since it is expected to stimulate creativity and high productivity. As a new business structure, IPD also ties compensation to achieving project objectives, which includes high quality and low waste through efficient team collaboration. Although language vary, currently all IPD agreements embrace Risk and Reward sharing by setting a risk pool that is directly affected by project team performance. By sharing the same benefits pool, parties become more concerned to optimize the whole project rather than their own part. Providing suggestions and assistance to other parties is encouraged, which meanwhile enables communication and collaboration.

Referring to Ashcraft (2011) [13], compensation in an IPD project should have three objectives:

1. To provide a return for a party's efforts and expertise;
2. To encourage teamwork of stakeholders and to stimulate collaboration and innovation;
3. To buffer cost overruns and ensure the project a success.

So, with the compensation strategy designed, the anticipatable overruns is acceptable and can be buffered.

Even though PTC is based on the TVD process, and all major parties get involved in the very early design phase and provide expertise in highly collaborated IPD environment, construction is full of uncertainty because of its one time products nature since PTC is defined in the early stage and early budgeting lacks the precision of later estimates. Contingency is expected to cover the uncertainties and unforeseen events which may not be caused by the team work, such as force majeure, different site conditions and marketing fluctuations. But contingency functions differently in IPD from it did in traditional delivery method, where different parties treat contingency differently. IPD is a trust-based, risk and reward sharing, highly collaborative system with open communication and transparent accounting strategy. Contingency is not unique for each party any longer: it serves the same purpose among the project team. Contingency is not necessary in every project, but it functions more than just cover the cost overrun when set into the project. Parties can share the contingency saving will encourage the project team consider the innovative method to figure out the solution in uncertainties or force majeure. In construction industry, it is not uncommon to provide performance incentives to contractors for early completion, quality work and adherence to safety rules and regulations [15]. Lam and Tang (2011) [16] found that effective rewarding system is an effective way to motivate employees.

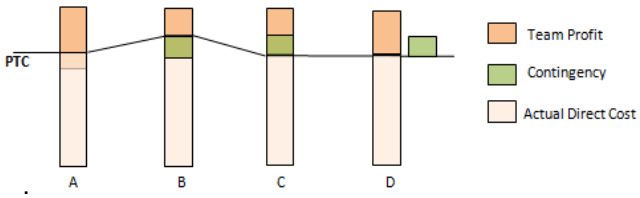

Figure 1 Contingency Allocation Options in IPD [13]

Figure 1 given by Ashcraft (2010) provides several options for setting up contingency into an IPD agreement. Option A leaves no contingency allocation. All project funds are used to achieve the project goals and team profit is assigned extra at a fixed number. Usually if the actual cost run over the budget, either the owner will take responsibility to pay the over portion or team profit will be used. At this time, tense relationship is easily to happen since people tend to transfer the risk to the other parties. Contingency is setting up within the PTC in option B. Team profit is fixed which means whatever the project will run under or over the target cost, each party will get the profit. Contingency could be considered in two ways: owned by owner or owned by team. When it is owned by owner, owner will get the contingency saving return and owner will be responsible for the contingency overrun. When it is owned by team, team members will share the contingency saving and the contingency overrun will be covered by owner. From the incentive point of view, contingency amount does not cause the team members anxious to try innovating method because the overrun will be covered in the project budget. From psychology, people tend to use the money for project without hesitation when they consider the amount as part of the budget. So owner alone takes the risk. In option D, the contingency is considered separately from the budget and unspent amount will be return to owner. But project team should have another backup plan for the case that the contingency is not sufficient for the changes. Another issue is which party decides the event should be covered by contingency, owner or project team. Conflict between stakeholders are easily to happen which will damage the high level trust and respect. In option C, contingency is outside of PTC which means contingency serves two functions: cover uncertainty and/or profit. Contingency saving based on team collaboration will be shared as profit by project team which encourage project team's motivation to apply innovative and collaborative decision making. All project parties share the risk.

Therefore, the structure of this incentive program must be designed much carefully. If the economic incentives are not set up properly, it would damage the intrinsic motivation, the team become less productive. From cases studies from California [10], the author finds that some IPD project participants experienced the incentive program are very essential while some other IPD participants hold the opinion that it damaged the team collaboration. From the comparison of the options, Option C motivates project team to collaborate together to perform innovation and creativity to complete the project under the budget and enjoy the benefit of their efforts.

With contingency allocated outside of PTC, seven possible compensation scenarios are discovered and shown in Figure 2. Contingency is allocated outside of PTC which means contingency serves to cover uncertainty and profit. While in practice, scenario three and four are the most likely situations in which contingency is acting exactly for two purposes: 1) buffering the cost overrun; and 2) acting as portion of profit. Scenarios five to seven are situations that stakeholders do not expect. The project team goals are as scenario one and two where cost under runs the direct budget and contingency add into the profit pool where team can really share based on the IPD team collaboration and innovation efforts. So from scenarios one to six, the profit pool is shrinking from real profit plus contingency plus cost saving to zero. Scenario seven is the worst situation where team is responsible for the cost overrun, even though it is very less likely to happen.

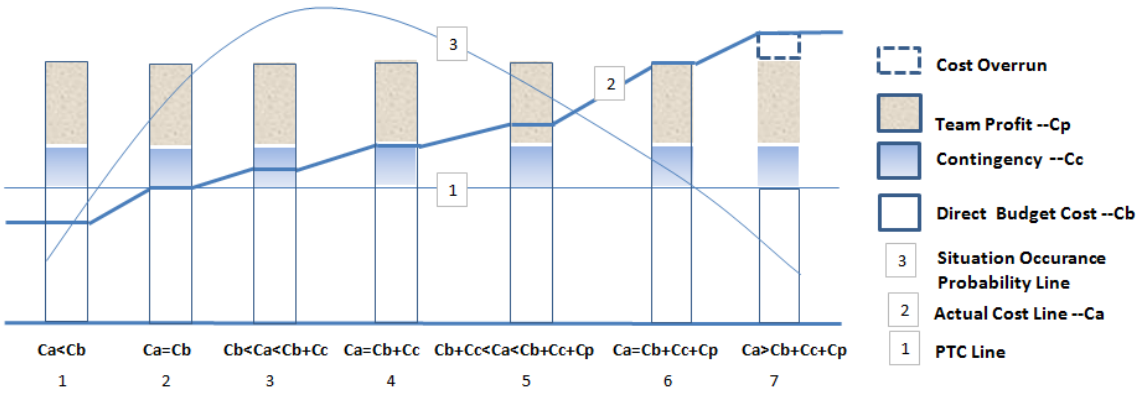

Figure 2 Compensation Structure Scenarios in IPD

Thus, from the compensation structure in IPD, contingency is actually acting as a rewarding system for encouraging the team if project team collaborates successfully. However, the amount of this incentive program must be designed very carefully. Estimating contingency at too high a level may kill the financing of a good prospect; but not estimating high enough may cause a financial disaster [17]. How to determine the appropriate amount for the contingency is critical to reducing the risk of cost overruns beyond the contingency. Throughout the construction industry, by simply calculating a "rule of thumb" percent of an

estimated baseline construction cost for the contingency amount, an estimator does not consider the likelihood of fairly predictable events during construction that typically result in change orders, thus reducing the utility of the contingency to provide budget stability and cover cost overruns.

5. A PROBABILISTIC CONTINGENCY CALCULATION MODEL

Contingency is not just a percentage of the project budget. Too much contingency will kill a good project prospect, but not enough will invite the intense relationships among the IPD parties. In traditional project delivery, contingency functions differently for different parties, while in IPD, contingency serves the same purpose for all team members. So allocation of contingency should base on the project team collaborative decision making in the early phase of the project and be transparent to all team during the project lifecycle. In best practice, a contingency estimation method should consider the changes features which includes identifying and understanding the risk drivers, addressing risk drivers using empirically-based data sets, and paying attention to the specific project category. A proposed example for the driven based model work flow is as Figure 3.

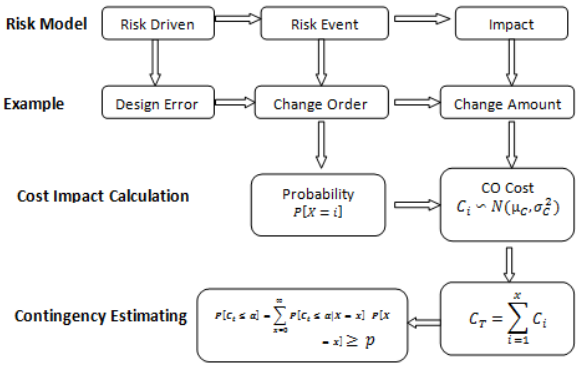

Figure 3 Probabilistic Contingency Calculation Model

First, this model considers the risk drivers which cause cost overrun, such as design errors. There are some other drivers, such as administrative change, non-material scope change, comptroller dispute determination, client agency request. During the construction, design errors will be recorded in form of change orders. Each design error has a dollar amount from which we can calculate the percentage based on the project budget. In order to prevent a cost overrun, the contingency required should cover the total change orders amount. In addition, for different categories of projects with specific characteristics, changes or uncertainties are not in the same tendency. Academic library projects will have different change orders trends from a health care building project. So project specific characteristics should be discovered by the model.

Unforeseen changes may result from random events that occur randomly during construction. This model also considers this characteristic and takes into account the probability of the changes or uncertainties happen. Contingency covers costs that may result from unforeseen and unpredictable conditions or uncertainties within the defined project scope. The project team writes these into the contracts by change order articles. Changes are random events and occur randomly during construction. From the empirical data, we can get the average occurrence rate of various types of changes. If we assume the uncertainty randomly happens by a Poisson distribution and the amount of changes series normally distributed with the average amount of the changes. Now, with the change order occurrence probability and change order mean cost, we can calculate the contingency needed to cover the cost overrun with a probability distribution. If the owner wants a confidence level of p against the cost overrun, the contingency α would be

$$P[C_T \le \alpha] = \sum_{x=0}^{\infty} P[C_T \le \alpha | X = x] \;\; P[X = x]$$

$$= \sum_{x=0}^{\infty} \left[\int_{-\infty}^{\alpha} \frac{1}{\sqrt{2\pi * \sum_{i=1}^{n} \sigma_{C_i}^2}} \; e^{-\frac{1}{2}\left(\frac{y - \sum_{i=1}^{x} \mu_{C_i}}{\sqrt{\sum_{i=1}^{x} \sigma_{C_i}^2}}\right)^2} dy \right] * \frac{e^{-(\lambda T)}(\lambda T)^x}{x!} \ge p$$

where, x is a random variable denoting the number of change orders, λ is the mean rate of the change orders, C_T is total cost changes rate, a is contingency rate and p is confident level that uncertainties will be covered. From this equation, given the contingency rate a, the probability of the cost overrun can be derived; given the confident level of p against cost overruns, the appropriate contingency needed can be computed. Figure 4 gives an example calculation based on a New York City public agency historical data set.

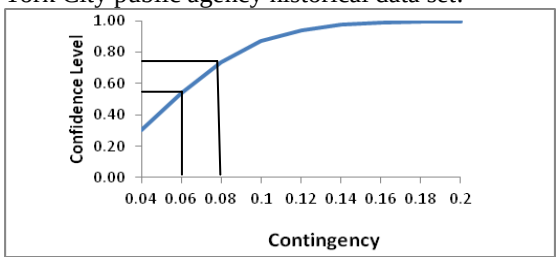

Figure 4 Contingency Allocations and Confidence Level

In this example, the average changes we are using are adopted from a public agency in New York City where the average changes are 6 and the average amount of the change is 1.0% of the project budget in a specific project category. From figure 4, if the team allocate 6% for contingency, the confidence that the uncertainties will be covered is 55%; if allocate 8% contingency, the team have the confidence will be 75%.

By applying the model, contingency can be properly allocated into the IPD project where all team have the confidence that the unforeseen events or uncertainties will be covered by the contingency.

8. CONCLUSIONS

IPD collaborates owner, designer, contractor and subcontractors into a project team by changing the adversarial relationship to being aligned through same goals and objectives. The team takes advantages of all team members to maximize the project outcomes and shares the reward and risk as well. Compensation structures in IPD are very different from those in traditional delivery methods and are expected to encourage the motivation, inspiration and creativity of stakeholders. To ensure an IPD success, it is necessary to set up compensation structures correctly and to determine the proper level of contingency allocation to reduce the risk of cost overrun. Compensation structures and scenarios are discovered in this paper; a probabilistic contingency calculation model is proposed by taking consider the random nature of the changes, the risk driven in a construction project, and using the agency historical data set. This model could equip the project team with confidence that the uncertainties will be covered by contingency in order to reduce the risk of cost overruns and really enjoy the benefits of IPD.

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