

# Identification of design-build project risk factors: contractor's perspective

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**Abstract.** Design-build in construction industry becomes one of the project delivery method selected by owner. Light rail transit, mass rapid transit, and stadium renovation are examples of large infrastructure projects which are constructed under design-build approach to save time. In this approach, the design and construction phases are carried out simultaneously by contractor. One of the advantages for owners is that most risks are transferred to the contractors. This paper attempts to discuss contractors' perspective related to risk factors in design-build project. The aim is to understand potential risk that can lead to an unsuccessful project. A questionnaire is developed that contains six factors with 20 sub-factors related to project risks. The questionnaire is distributed and responded by both state-owned and private enterprises contractors that involved in design-build project. Data are analysed using Significance Index method in order to obtain the relative significance of the risk sub-factors. The result shows five influenced sub-factors including project and program management issues that may cause risk to the contractor's success under design-build project.

## 1 Introduction

Indonesia is currently intensifying infrastructure development to promote national socio-economic growth. To increase competitiveness and national productivity, until the first quarter of 2018, Government of Indonesian has budgeted more than 200 billion USD in 233 infrastructure projects nationwide [1]. In order to meet the national goal and accelerate its development, a different procurement method is introduced which is considered a way to reduce construction time.

Design-Bid-Build (DBB) is the most common method of procuring construction service providers in a variety of construction projects around the world, where design and construction activities are carried out in different contract packages by different service providers. In Indonesia, DBB is also a common method in the construction industry. However, to encourage innovation, improve cost performance and project scheduling, the project Owner (i.e. government) begins reviewing alternative methods of providing construction service. Design-Build (DB) is an alternative project delivery method in which design and construction activities carried out in a single package construction contract by

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the service provider [2]. Based on the perspective of project risk management, with the additional scope of work for the Contractor (design and build), there is more risk for the Contractor than the project Owner [3]. The shifting of risk allocation between parties where the risk for Owner is lessening in DB compares to DBB method.

The complexity of a construction project is directly proportional to the level of uncertainty or risk [4]. Project risk may affect the project objectives directly. From a risk management perspective, in order to ensure that the cost-time-quality objectives of an infrastructure project are not affected by risk, the project Owner (i.e. the government) can mitigate some of those project risks by transferring or sharing them to other project entities [5, 6]. This entity, which is called as Contractor, is responsible for the performance and objectives of the construction project. In order for the contractor to achieve the project objectives set by the Owner, it is necessary to identify risk factors that may hinder the success of the project. The more risks that can be identified in the initial phase of the project, the greater the chances of successfully achieving the project objectives [7].

## **2 Design-build project delivery risks**

DB is a project delivery method in which the design and construction activities are contracted out to a single entity commonly referred to as a DB contractor [8]. DB procurement system began to be widely used for national infrastructure projects. The Indonesian government started to adopt the DB delivery method on several of its infrastructure projects. Some advantages for the Owner to adopt DB method include fasten project completion and minimize the Owner's project risk [8, 9]. These researches show that DB approach is 12% faster than the DBB delivery method based on the number of jobs per square meter and 33% faster based on design speed to the implementation stage. However, the researches prove that based on the number of jobs per square meter DB projects are 6% more costly than DBB ones. From the owner's perspective, the new method minimizes their risk of the project by having a single-point responsibility on the Contractor's side.

In response to the construction industry's demand for DB delivery method application, contractors must adapt accordingly. Contractors must recognize risks associated with DB project. As the Contractor's project scope increases, the risks of the project for contractors also increase. From previous researches, six major risks are identified in DB projects namely: scope risks, third party and complexity risks, construction risks, Right-of-Way (ROW) and utility risks, design and contract risks, and management risks [10-13].

### **2.1. Scope risk**

Scope risks are all risks related to the project scope, including 1) project definition, 2) scope definition, 3) staff experience and availability, and 4) conformance to the local regulations, standards, and documentation. A clear definition of the project scope will minimize the estimated contingency cost in the proposed DB contractor bids. The unclear scope is the main cause of delays in project completion and cost overrun [14].

The project scope definition is written in the RFP document made by the Owner's team staff which will then be read and reviewed by the Contractor's staff. The competence and experience of project staff are crucial in defining the project scope. The success of the DB project depends on the competence and availability of the project's human resources [10].

Local regulations relate not only to the internal stakeholders of the project (i.e. Owner and Contractor) but also to the project's external stakeholders. Design criteria, standards, and regulations that may affect the project deliverables should be informed to the Contractor's team in the initiation phase to establish the limitation in the project [10].

## **2.2. Third-party and project complexity risk**

The third party and complexity risks factor consists four sub-factors i.e. 1) project complexity, 2) approval from other agency, 3) delay in utility relocation, and 4) defined and undefined hazardous wastes. Project complexity becomes a major risk to DB project objectives. Usually, it has several elements: ROW, traffic management, structure, utilities, environmental issues, and stake holders. The role of project control is crucial to handle the project complexity by maintaining control and project oversight [15]. Apart from internal stakeholders, DB project may face some risks from the external stakeholder or third parties as utility owners, local agency, police, NGO, etc. These risks are related to approval impediment by the local agency regarding existing utility and/ or design. Delay may occur due to the impediment and have a direct influence to DB project schedule [10]. The risk related to the environmental issue in the DB project is also borne by the contractor. Hazardous waste on the project can lead to high costs due to its pollution. The contractor needs to focus on material selection and waste management to minimize this risk [10].

## **2.3. Construction risk**

Construction risks are all uncertainties within the construction activities. The most common construction risk in DB projects is the degree of geotechnical investigation since the design stage is under contractor responsibility [16]. In some cases, a geotechnical survey has not been conducted due to time limitation before contract signing. Consequently, this activity cannot be priced and the Contractor has to allocate a large contingency to cover the worst possible scenario caused by a geotechnical investigation result [14].

Traffic management plans for construction projects, especially those that take place near public roads, are important. In the DB project, if the traffic management plan is not clearly defined in the proposal, the project will face problems with access for heavy equipment and construction materials. Poor traffic management will reduce work productivity, which results in delays to overall project schedules [10].

Environmental risks will always have a substantial impact on project costs and time, especially in the DB project. Environmental risks closely associated with the risk of a third party; for example, any design changes that occur must be approved by the relevant agency that is not part of the project organization. Thus, Owner and Contractor have no control unless design changes approval is obtained from the relevant agency [17].

In the DB project, the Owner must clearly state the design and construction quality objectives to be met by the Contractor [18]. The DB contractor is fully responsible for the project QA/QC process and time constraints that may affect the Contractor's performance.

## **2.4. Right-of-Way and utility risks**

Right-of-Way (ROW) risks are all project risks associated with access and work areas where contractors are allowed to carry out construction activities. ROW is obtained from the process of land acquisition and/ or utility relocation. Obtaining ROW is a complex process with high uncertainties since it involves third parties with almost no interest in the project, but highly influential [19]. Delay in obtaining ROW can significantly postpone the whole project schedule and causing cost overruns.

Utility relocation consists of 2 stages. First is identifying the existing utility, and the second is moving it. Similar to the land acquisition process, obtaining ROW by relocating existing utilities can be complicated and highly uncertain. Complications of the utility issue can come from the negotiation process with the utility owner [10].

## **2.5. Level of design and contract risks**

Although both design and build scopes are under Contractor's responsibility, the Owner shall still provide sufficient initial design to be explained in the tender phase. The level of detailing in the initial design for the tender is important. Some opinions suggest that the initial design from the Owner should include information on field conditions that have high uncertainties such as soil conditions or groundwater levels [10]. Another consideration that may contribute to the risk faced by the contractor is a construction contract. A construction contract is a tool for distributing construction project risks from Owner to Contractor. However, construction contracts are often unclear causing a threat to the Contractor. The ambiguity is generated mainly due to the terminology used. Legal language used in the contract cannot adequately explain technical specifications.

## **2.6. Management risk**

Management risks consist of two major risk sub-factors. They are program and management risks as well as insurance risks. A large infrastructure program is usually divided into several project contracts. Some projects can run simultaneously on the site. Therefore, resource conflicts, both at the program level by the Owner and the subcontract level by the Contractor often occur. Poor multi-project management will lead to resource distribution problems which later delays projects and programs as a whole.

Insurance is another issue in DB projects that requires some consideration. Contractor's main concerns in this issue related to protection from claims of errors and omissions about the design. In conventional DBB project, the design consultant provides design errors and omissions insurance, while contractors provide performance and payment bonds. Friedlander [20] explains that since contractors' general liability policies usually have little or no deductible while professional liability policies have large deductibles, these policies may have disparate impacts on the DB team. Insurance can be highly risky due to the onerous insurance requirement set by the Owner [10].

# **3 Methodology**

## **3.1 Survey design**

A comprehensive review of literature was conducted before the survey to understand the risks involved in the DB project. The questionnaire covered six risk factors and 20 sub-factors. Data collection was conducted in 2018 to both state-owned and private enterprises contractors that involved in the DB project. The number of questionnaires distributed was 70. A total of 46 filled questionnaires were returned which reflect effective return rate of 66%. The respondents profile is in Table 1. As shown in Table 1, forty respondents (86.96%) were the state-owned enterprise since most of the infrastructure projects utilize the DB approach and as government's project was carried out by the state-owned enterprise. According to Regulation of the Minister of Public Works and Housing Number 12/PRT/M/2017 regarding Standards and Guidelines for Integrated Construction Procurement of Design and Build, the application of DB approach is encouraged for government's project to increase innovation and accelerate infrastructure development [21].

The table also shows that the DB project is considered a new procurement method in the construction industry in Indonesia. The respondents' length of experience and involvement in the DB project are still limited. For government's project, the earliest regulation for the design-build method is Regulation of the Minister of Public Works and Housing Number 19/PRT/M/2015 [22].

**Table 1.** Respondents characteristics

Job characteristics	State-Owned enterprise		Private enterprise	
	Number	Percentage	Number	Percentage
Years of involvement in design-build project				
Less than 3 years	15	37.50%	3	50.00%
$3 < x \leq 5$ years	4	10.00%	0	0.00%
More than 5 years	13	32.50%	2	33.33%
NA	8	20.00%	1	16.67%
Total	40	100.00%	6	100.00%
Number of design-build project involved				
1-3 projects	19	47.50%	3	50.00%
4-5 projects	6	15.00%	0	0.00%
More than 5 projects	3	7.50%	2	33.33%
NA	12	30.00%	1	16.67%
Total	40	100.00%	6	100.00%

### 3.2 Analysis technique

The respondents were requested to rate their perspective on the significance of risk subfactors that may influence the success of DB project performance. For each sub-factor of risk, a six-point Likert scale is given, starting from 0 at least significance until 5 as the most significant risk sub-factor that affect the success of DB project. Significance index adopted from Zhang [23, 24] is applied in the analysis to convert the scale used in the questionnaire to a 0-100 scale for ranking the sub-factors. The formula is as follows:

$$S_i = \frac{R_{i0} \times 0 + R_{i1} \times 20 + R_{i2} \times 40 + R_{i3} \times 60 + R_{i4} \times 80 + R_{i5} \times 100}{R_{i0} + R_{i1} + R_{i2} + R_{i3} + R_{i4} + R_{i5}} \quad (1)$$

where  $S_i$  = significance index for the  $i$ th sub-factor,  $R_{i0}$  = number of responses as “0” for the  $i$ th sub-factor,  $R_{i1}$  = number of responses as “1” for the  $i$ th sub-factor,  $R_{i2}$  = number of responses as “2” for the  $i$ th sub-factor,  $R_{i3}$  = number of responses as “3” for the  $i$ th sub-factor,  $R_{i4}$  = number of responses as “4” for the  $i$ th sub-factor,  $R_{i5}$  = number of responses as “5” for the  $i$ th sub-factor.

## 4 Results and discussion

For the 20 risk sub-factors asked, the significance index response rating values range from 86.24 to 72.70. The highest rank is for risk sub-factor of project and program management, and the lowest rank is unexpected utility encounter. The result in Table 2 indicates that all of the risk sub-factors are considered important in determining the success of DB approach. The top five DB risk sub-factors identified are 1) project and program management, 2)

project complexity, 3) construction quality control/ quality assurance (QC/QA), 4) insurance, and 5) work zone traffic control.

**Table 2.** Results on significance indexes of risk sub-factors in design-build project.

Risk sub-factors	Number of responses						Mean	Standard Deviation	SI	Rank
	5	4	3	2	1	0				
Project and program management issues	22	16	6	1	0	0	4.31	0.79	86.24	1
Project complexity	20	16	8	1	0	0	4.22	0.82	84.47	2
Construction quality control/quality assurance (QC/QA)	18	21	6	1	0	0	4.22	0.76	84.37	3
Insurance	14	21	9	1	0	0	4.07	0.78	81.36	4
Work zone traffic control	12	24	8	1	0	0	4.04	0.74	80.91	5
Geotechnical investigation	17	17	10	1	1	0	4.04	0.94	80.89	6
Design completion	16	22	5	1	1	1	4.04	1.05	80.89	6
Conformance with regulations/guidelines/documentation	14	23	7	2	0	0	4.07	0.80	80.48	8
Environmental impact	16	20	7	3	0	0	4.07	0.88	79.63	9
Defined and nondefined hazardous waste	16	18	8	2	0	1	4.00	1.04	79.16	10
Delays in Right-of-Way process	11	21	13	0	1	0	3.89	0.85	78.70	11
Single or multiple contracts	13	20	11	1	0	1	3.91	0.98	78.28	12
Challenge in appropriate environmental documentation	10	24	10	2	0	0	3.91	0.78	77.43	13
Scope definition	12	20	12	2	0	0	3.91	0.84	77.43	13
Staff experience/availability	13	17	13	2	1	0	3.85	0.97	76.13	15
Unclear contract documents	14	17	11	3	1	0	3.87	1.00	75.72	16
Project definition	14	17	10	5	0	0	3.87	0.98	74.02	17
Obtaining other agency approvals	6	24	14	1	0	1	3.70	0.89	73.93	18
Delays in completing utility agreements	11	22	7	4	1	1	3.76	1.12	72.70	19
Unexpected utility encounter	12	20	8	4	1	1	3.76	1.14	72.70	19

Project and program management as management risk's sub-factor is identified as the most important sub-factor that determines the success of the DB project. Synergy among project team member is highly important in the DB project. DB scope of work affects the program management in term of the additional management activities as a whole organization. The addition to management activities will result in additional documents that need to be developed, checked, and informed to each of project team members involved. Thus, the information and communication flow in the project becomes more complicated.

In the DB project, teams involved in it work simultaneously. Any horizontal conflict among teams needs to be avoided as well as a conflict that may occur later in the next phase.

The complexity of the DB project becomes the second highest risk sub-factor with SI of 84.47. As discussed previously, DB project complexity firstly originated from ROW issue. Before the construction activities on site begin, the Contractor must not only ensure the detailed design already approved by the Owner but also obtain ROW from Owner. Before handing over ROW to the Contractor, Owner has to make sure that the construction design by the Contractor meets the pre-construction requirements regarding e.g. the design must not be interfering with existing utilities and/or roadways, and environmental issue.

The third in the risk sub-factor rank is construction quality control/quality assurance (QC/QA) with SI of 84.37. DB Contractor must follow the Outline Design Specifications (ODS) and Outline Construction (OCS) where all requirements for design and construction are written within the contract. In addition to construction activity products, design activity products must also go through the QC/QA process. Thus, there is a risk of delay in starting construction activities when design documents do not meet the QC/QA requirements. Later in the construction phase, the contractor has to maintain that all the works performed are met with the specifications. It is necessary to have a team that works in both phases who monitors and controls the design and result of each work item.

In traditional procurement, the Contractor provides insurance to cover losses due to damage during the construction process. The damage covered includes both in the form of bodily injured workers and building damage. However, in the DB project, insurance coverage also includes losses caused by design defects. The problem is often raised when the form of a design defect is difficult to translate. In some cases, insurance can protect due to design defects that cause physical disability or damage to buildings although most general insurers exclude liability due to design errors [25].

Work zone traffic control is also considered as an important risk sub-factor to the success of the DB project. Most of the DB projects in Indonesia are infrastructure projects located around the urban area. The condition requires a traffic management plan to avoid any disruption to the traffic that is almost always congested during the daytime. Another consideration for a project in the urban area is related to the regulation for the movement of project's vehicles. Regulation restricts project vehicles to move around certain street during the day. As a result, in the early project, traffic management plan should recognize all the constraints that may risk the project during construction.

## **5 Conclusions**

The only thing that is certain is uncertainty, even for the construction industry. The more complex the project delivery system, the more the risks are at hand. Research conducted shows that there are six risk factors with 20 risk sub-factors that may become threats to design-build project success. Among the 20 risk sub-factors, project, and program management is identified as the most important sub-factor that determines the success of a DB project. The scope of work under the contractor's responsibility becomes substantial causing the need to have a well-planned project and program management.

Other risk sub-factors that are identified as the risk in DB project including project complexity, construction quality control/ quality assurance (QC/QA), insurance, and work zone traffic control. Contractors involved in the DB project consider that the top five risk sub-factors are the part of third party and complexity risks, construction risks, and management risks. Thus, those three risks are considered as the risk in DB project that should be taken into consideration when a Contractor enters into this type of project.

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