

# EFFECTIVE COST MANAGEMENT OF CHINA MEGA PROJECTS

Zhang Daping, MRICS, MAIQS

**TRUTHS Project Consulting Ltd**  
*10th Floor Tower A, Hundred Island Park Bei Zhan Bei Jie Street,  
Xicheng District, Beijing 100044 China*  
*zhang\_daping@truths.com.cn; daping122@tom.com; 1411250257@qq.com*

## **Abstract**

Recently, there are more and more mega projects in China. The cost control of mega projects is a challenge to the cost management agency, because of the technology complexity, long construction period and unexpected events. This presentation demonstrates how mega project budgets are controlled effectively. Effective procedures based upon the design-bid-build delivery methodology are demonstrated to control the cost of the project. Methods are illustrated including managing owner's requirements, controlling design and risk mitigation during the construction period.

**Keyword:** cost management, mega project, owner requirements, design, risk control

## **INTRODUCTION**

Following the rapid growth of China construction industrial, many mega projects have been built in China. As one of the large construction management firm in China, THUTHS Project Consulting Ltd. had managed many mega projects successfully in cost control field in China. Such as 2008 Olympic National Stadium—Bird's Nest, 2008 Olympic Water Cube-National Aquatic Center, Beijing Metro lines, Beijing concessional projects to support Sichuan's post-disaster reconstruction, industrial, residence and public buildings in China.

Cost management and risk mitigation theory had been researched by THUTHS for many years. A integrity work flow for cost management had been set up to control cost, and portfolio management methods were used to mitigate the risk based upon the design-bid-build delivery methodology.

Recent researches and literature of cost management in mega projects most concentrate on design budget control and cost management in construction phrase.

The typical objectives of design phase cost management are to do the following: Estimate an adequate and accurate budget, Ensure that bids are within budget, Ensure alignment of budget / scope /owner's requirements, And minimize risks because of cost overruns (Venkataramani Sundaram, 2008). Cost management during the design phase not only requires estimators but also all the design team members should have cost conscious approach. All members of the design team should play an active role in defining and controlling project costs, cost control as a

design tool to be used to minimize the risk of cost overruns(Venkataramani Sundaram, 2008). That give a challenge to China design firms, it will increase cost of design, design firm has no enthusiasm to cost control after design bidding. So it is very difficult to control cost in design phase in China.

It is necessary to ensure the requirements to balance its with owner's affordability before design bidding, And through design bidding to select a design firm to promise to control the design budget under estimate.

For above reasons, a cost management process(include owner's requirements, controlling design budget) to be put forward to control cost effectively .

Most literature discuss the risks controlling and improving performance major carried with contract, risk allocation (RA)(Lam K C and etc. 2007; Jin Xiaohua 2010) be structured by initial risk allocation (IRA) and risk reallocation for contract performance (Li Pengjuan 2014) based upon the design-bid-build delivery methodology. Except contract management, schedule control to be put forward as a key method to mitigate the risk of China mega projects in the paper.

## **ANALYSIS THE RISKS OF COST MANAGEMENT**

### **Features of China Mega project**

Wherever the it is in the world. the mega projects all possess the features of function complexity, technical complexity, long duration, inflation, multi-specialty teams cooperation, and unforeseeable events etc. These features caused many budget risks of mega projects(in owner aspect) during it implement period. Expect the common characters of mega project, China Mega projects have the character of very urgency schedule, that means schedule management must be considered in cost management from beginning to the end.

### **Analysis the risks of cost management**

#### ***Owner's requirements risk***

General functions(scope) and it's attached is required by owner, the adjustment of function(scope) will affect estimate and cause variations in construction, contractor claims will happen due to the variations. Although it is impossible that there are no variations in construction, to minimize the variations in construction is our target in phase of decision of owner's requirements.

#### ***Design budget control risk (DBB delivery methodology)***

Mega projects have the technical complexity feature, the value engineering method should be used to assess the technical program in scheme design, as scheme design will decide the 70%--85% of the cost of the project. Design uneconomical and omissions will not only cause the design budget beyond the estimate but also cause contractors claims during construction period. and affect the cost of life cycle.

#### ***Multi-disciplined teams cooperation risk***

For mega projects, there are many general contractors (many construction sections), sub-contractors, nominated sub-contractors, material and equipment suppliers etc. The cooperation quality of them will affect the schedule and cost of the project. The contract plan and arrangement is the key element to cost management.

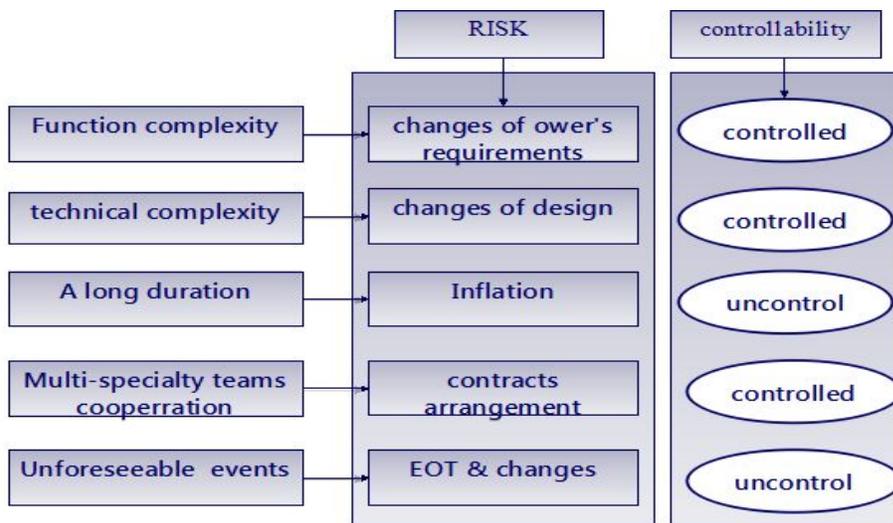
**Long duration risk**

The inflation (materials and labor price rise) will be happened due to the long duration of the project and the price fluctuation will cause the budget overrun. Schedule control should be considered from the beginning to the end of the project.

**Unforeseeable events risk**

Some Unforeseeable events such as policy change, Force Majeure etc. will delay the duration of construction and cause claims of contractors.

**Table 1** Demonstrate the Analysis the risks of cost management



Through analyses the risks characters, we find some risks are controllable and some risks are uncontrollable, a portfolio methods and a cost management process are put forward to control controllable risks. For uncontrollable risks, the methods of risk mitigation risk transfer risk buffering and risk avoidance have been used such as insurance and contract plan to control cost.

In the process, different phase will mitigate the above risks correspondence.

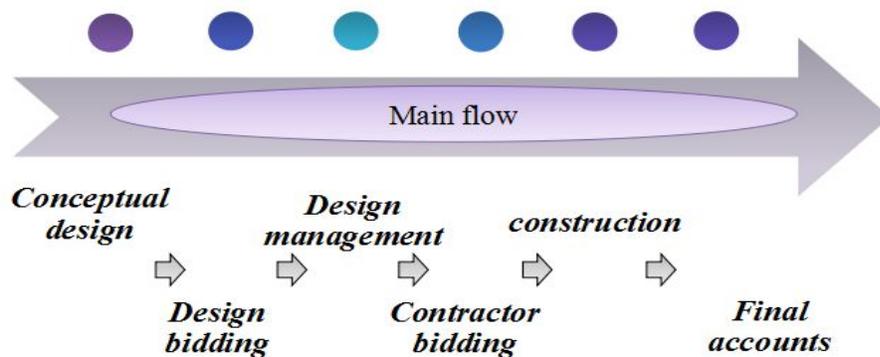
- Conceptual design phase will settle changes of owner's requirements
- Design bidding and Design management phase will control design budget and decrease changes in construction period.

- Contractor bidding phase will arrange the contract plan to lower Multi-disciplined teams cooperation risk and mitigate the long duration and Unforeseeable events risks.
- Construction management phase will optimize the detail design and control cost in budget.
- Schedule plan have been considered in the process to mitigate the risk of inflation.

## COST MANAGEMENT PROCESS

The cost management process includes conceptual design phase, design bidding phase, design management phase, contractor bidding phase, construction management phase and final account phase.

**Table 2** Cost management process



17

### *Conceptual design phase*

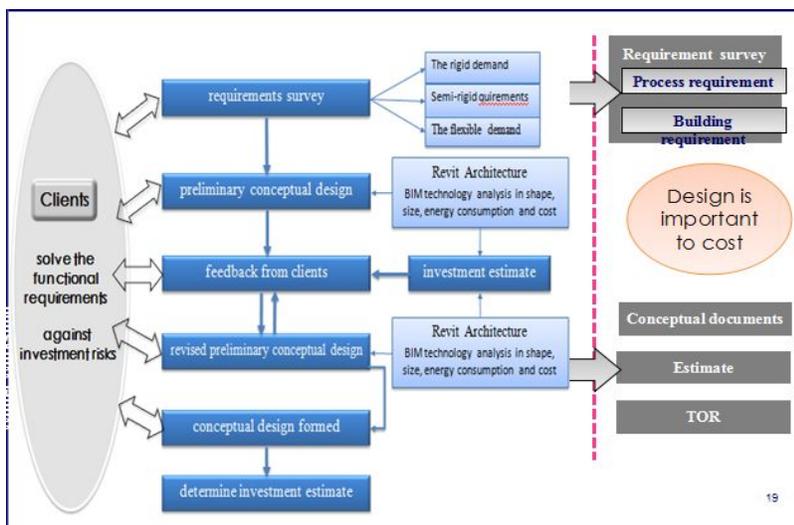
We will manage the requirements to balance them with client 's affordability and estimate the requirements. The final estimates will be the baseline of the project. See **Table 3**

Steps as following:

- Requirements Survey Forms will help clients to find what is their necessary demands. When fill in the Requirements Survey Forms, selected items are given and specialties will assist them to choose the function and scope. The criteria and standards describe the common function of this type of building including architecture characters (area, space, shape, appearance, material, etc), structure characters (load capability, seismic intensity, etc), equipment (HVAC). See **Table 4** .

- Requirements will be definite according to rigidity requirements (Standards), semi-rigidity requirements, and flexibility requirements. Rigidity requirements are the main function and scope. For semi-rigidity requirements, and flexibility requirements, value engineering analysis will be serviced as to decide whether it will **be considered**. The criteria and cost data of different types of building will be used, the cost data are classified according to the location and time.
- BIM technique used to illustrate 3D graphics to clients. See **Table 5**
- It is imperative that all the elements of the budget/scope **are determined clearly** (Alphonse Dell' Isola 2009)
- The bidding documents and terms of reference specification (TOR) to design firm will be completed
- The output documents of Conceptual design including: Requirements Survey Forms; Estimate and Contingency; Conceptual design and BIM model; The bidding documents and TOR to design firm

**Table 3** Conceptual design phase



**Table 4 Requirements Survey Forms**

### Requirements survey tables

**第一章 总则**

**第二章 项目基本信息**

**第三章 物流规划总图需求**

3.1 规划设计条件要求

3.2 总平面布局要求

3.2.1 功能定位与需求规模

3.2.2 装卸区及回转区域要求

3.2.3 道路交通规划

3.3 物流工艺需求

3.3.1 仓库储存需求

3.3.2 仓库物流要求

3.3.3 物流动线要求

**第四章 建筑专业技术需求**

4.1 仓库建筑需求

4.1.1 仓库平面

4.1.2 仓库立面

4.2 办公楼建筑需求

4.3 宿舍楼建筑需求

4.4 其它附属建筑需求

4.5 室外工程需求

**第五章 结构专业技术需求**

5.1 仓库结构形式

5.2 荷载要求

5.3 连接体系

**第六章 给排水、通风空调专业技术需求**

6.1 给排水系统

6.4 通风与空调专业

**第七章 电气专业技术需求**

7.1 供电电源系统、供电方式

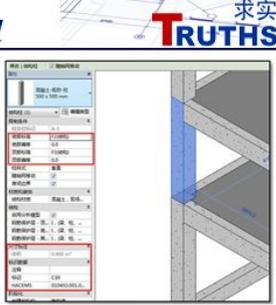
(3) 储运要求<sup>1)</sup>

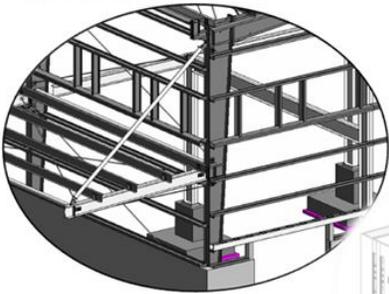
总储存量 <sup>2)</sup>	最大值: _____ 托盘(料箱) 平均值: _____ 托盘(料箱) <sup>3)</sup>
平均库存周期 <sup>4)</sup>	_____
温度要求 <sup>5)</sup>	_____ °C ~ _____ °C      %RH _____ %RH <sup>6)</sup>
存储系统配置 <sup>7)</sup>	<input type="checkbox"/> 平面堆放 <sup>8)</sup> <input type="checkbox"/> 托盘货架 <sup>9)</sup> <input type="checkbox"/> 货架储存 <sup>10)</sup> <input type="checkbox"/> 驶入式货架 <sup>11)</sup> <input type="checkbox"/> 立体库 <sup>12)</sup> <input type="checkbox"/> 重力式货架 <sup>13)</sup> <input type="checkbox"/> <input type="checkbox"/> 穿梭货架 <sup>14)</sup> <input type="checkbox"/> <input type="checkbox"/> 阁楼货架 <sup>15)</sup> <input type="checkbox"/> <input type="checkbox"/> 流利式货架 <sup>16)</sup> <input type="checkbox"/> <input type="checkbox"/> 其他货架 <sup>17)</sup>
储存方式选择 <sup>18)</sup>	<input type="checkbox"/> 固定储存 <input type="checkbox"/> 按货物尺寸分类 <sup>19)</sup> <input type="checkbox"/> 随机储存 <input type="checkbox"/> 按货物品种分类 <sup>20)</sup> <input type="checkbox"/> 分类储存 <input type="checkbox"/> 按储存时间分类 <sup>21)</sup> <input type="checkbox"/> 分类随机储存 <input type="checkbox"/> 其他分类 <sup>22)</sup>
不同存储系统 <sup>23)</sup> 容量需求 <sup>24)</sup>	<input type="checkbox"/> 平面堆放容量: _____ <sup>25)</sup> <input type="checkbox"/> 托盘货架容量: _____ <sup>26)</sup> <input type="checkbox"/> 驶入式货架容量: _____ <sup>27)</sup> <input type="checkbox"/> 重力式货架容量: _____ <sup>28)</sup> <input type="checkbox"/> 穿梭货架容量: _____ <sup>29)</sup> <input type="checkbox"/> 阁楼货架容量: _____ <sup>30)</sup> <input type="checkbox"/> 流利式货架容量: _____ <sup>31)</sup> <input type="checkbox"/> 自动化立体库容量: _____ <sup>32)</sup> <input type="checkbox"/> 其他容量: _____ <sup>33)</sup>
	<input type="checkbox"/> 托盘搬运车 <sup>34)</sup> <input type="checkbox"/> 平衡重式叉车 <sup>35)</sup>

**Table 5 Establish the BIM model**

### 3.1.2. Establish the BIM model

- estimate according to the BIM model






### Design bidding phase

As the cost control has no direct benefit with design firm, it is very difficult for design team to play an active role in defining and controlling project costs, it means for them to extend the design period and increase the cost of design if they pay more attention on cost control, while the

performances of cost control by design firm is very hard to measure. In order to control design budget, design bidding is useful to overcome this problem.

In design bidding phase, Cost Breakdown Structure is established in accordance with estimate. Pareto's Law states that 80 percent of the effort is spent on 20 percent of the work. We will find the 20% items(e.g. For R.C structure, steel bar and concrete are the items which be included in the 20% items) which affect the 80% cost in the budget. Main price of the 20% items (e.g. For R.C structure, the price of steel bar per ton and the price of concrete per m3) will be fixed and the quantities of 20% items will be competed by design tenderer, the tenderer must give the competent budget of the project and commit the cost should be controlled under it. Budget of the project will be considered as a key element to select the success tenderer.

### ***Design management phase***

TOR will become a guidance to design firm during design period, the design budget should be checked in preliminary design and detail design phase by owner or consulting firm. In preliminary design, the Multi-discipline technical proposal will be researched and discussed by using value engineering method. In detail design, the scope creep, design mistakes, conflicts, duplication and omissions should be prevented, so as to be fewer change orders later on. It is also necessary to review constructability of design and specifications.

### ***Contractor bidding phase***

Contract plan will be decided in contractor bidding phase, and fast schedule and how to share risks must be considered as a key element. the construction sections and the contract type(unit price contract or lump sum contract) must be chosen according to the project's special circumstance. Contract plan also should include sub-contractor and nominated sub-contractor and provisional sum.

### ***Construction management and final account phase***

In construction management phase, changes control and detail design optimization is helpful to control budget. When the variations happen, we will categorize the variations as following:

- Owner's variations
- Designer's variations
- Contractor's variations

For the Owner's variations, we will analysis them according to the procedure of Conceptual design and the detail design will be reviewed. the price of the variations will be compared with the budget of the project. If it is necessary the value engineering method will be used to determinate how to alternate. But the variation can be accepted only under the circumstance of the price lower than the budget.

For the designer's variations, the reasons should be stated by designer and the optimization should be considered when does the variations design. The variations can be accepted only under the circumstance of the price lower than the budget.

For the contractor's variations, the variations should be done in accordance with the contract's procedure. Schedule, price and other relative elements must be assessed before variations. But the variation can be accepted only under the circumstance of the price lower than the budget.

And when the above phase does well in the process the final account will be easy and quick.

## **SCHEDULE PLAN**

For most China mega projects, the demand of schedule is strict. The schedule plan should be drawn up in the beginning of the project. It will be taken into account in Conceptual design phase, design bidding phase, design management phase, contractor bidding phase and construction management phase. In construction period, cost control will benefit from fast schedule although labor force working at the same time will increase cost of contractors. Fast schedule can hedge against inflation and decrease the happen probability of unforeseeable events. Both of theirs risks are uncontrollable by owner. Objective, China mega projects have been benefited from fast schedule demand.

## **CONCLUSION**

This paper have demonstrated a effective cost management process through analyzing the cost management risks of China mega projects based upon the design-bid-build delivery methodology. The working phase of the process can withstand the risks of mega projects correspondence. Conceptual design , design and contractor bidding and design management are the main cost control tools to manage controllable risks of China mega projects budget by TRUTHS project consulting firm. This portfolio methods will control cost effectively. Schedule plan is a key method to mitigate uncontrollable risks of mega projects. Many China mega projects cost control effectively benefit from fast schedule.

## **REFERENCES**

Virginia A. Greiman Mega project Management: Lessons on Risk and Project Management from the Big Dig John Wiley & Sons, Inc. Published 2013

Li Pengjuan and Yin Yilin(2014) The 18th Pacific Association of Quantity Surveyors Congress 2014 [D], Hong Kong 433-477.

Venkataramani Sundaram, Essentials of Design Phase Cost Management and Budget Control [J]. Cost Engineering Vol. 50/No. 2 FEBRUARY 2008 24-28

A1phonse Dell' Isola PE Value Engineering: Practical Applications - Copyright 2009 - RSMMeans/Reed Constructions Data

PMI (Project Management Institute). 2013. A Guide to the Project Management Body of Knowledge (PMBOKR Guide)—Fifth Edition. Newtown Square, PA: Project Management Institute.

Ripley, P. W. 2004. “Contingency! Who owns and manages it?” AACE International Transactions: CSC.08.1–CSC.08.4. SAIC 2002.

Touran , A., and P. J. Bolster. 1994. Risk Assessment in Fixed Guideway Transit System Construction. Washington, DC: Federal Transit Administration.

Oudot J M. (2005)Risk-allocation: theoretical and empirical evidences, application to public-private partnerships in the defense sector[A]. The 9th Annual Conference of the Institutions of Market Exchange[D]. Barcelona, Spain, 23-25.

Lam K C, Wang D, Patricia T K, et al. (2007) Modelling risk allocation decision in construction contracts[J]. International Journal of Project Management, 25(5): 485-493.