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Major Issues for the Implementation of an Effective Cost Management for Super High-Rise Buildings
超高层项目全过程造价控制实施要点

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Abstract | 摘要

Developers of super high-rise buildings in China often engage international designers for preliminary and schematic design, while Local Design Institutes in China are responsible for the design of the construction drawings. The construction drawings provided by local design institutes are produced in accordance with Chinese practices. The drawings however do not entail many details, which result in a lot of issues and eventually affect project delivery, cost and quality. To meet the above challenges, this paper provides some effective measures for achieving best value and for protecting the developer's financial interest in the implementation of the project.

Keywords: Design Team, Drawings & Specifications, Fixed Lump Sum Contract, Full Cost Control, Procurement Method, and Variation

中国超高层项目业主一般会聘请国际建筑师负责项目的方案设计及扩初设计，而施工图设计则交由本地的设计院承担。其设计深度及质量往往不能满足准确计量及包干计价的要求，以致严重影响项目的工期、造价、质量的有效控制，最终可能导致造价失控。就如何解决上述问题，本论文作出多项建议，以协助控制支出，达致物有所值。

关键词：设计团队、图纸及规范、总价包干合同、全过程造价控制、承发包模式、工程变更

Developers of super high-rise buildings in China often engage international designers for preliminary and schematic design, while Local Design Institutes in China are responsible for the design of the construction drawings. As the detailing of construction drawings prepared by Local Design Institutes, they are all in accordance with China practices, which are in line with the traditional fixed unit rates method (similar to published Schedule of Rates) and re-measurement arrangement. Therefore, based on the design detailing and quality of such construction drawings, quantities cannot be measured accurately from the drawings in order to produce a lump sum. For example, Local Design Institutes will not provide technical specifications and are not responsible for the design of construction details for the specialized works such as curtain wall, ELV etc., and some of the detailed designs are commenced only after the procurement of the equipment by the developer. So, that caused lots of challenges and constitutes great difficulties in the implementation of effective cost management and will eventually affect the delivery, cost and quality of the project (Figure 1). Some common cost control issues in relation to local super high-rise building projects are listed as follows:

A. Based on the above reasons, developers are not able to conduct an accurate and comprehensive economic analysis

中国超高层项目业主一般会聘请国际建筑师负责项目的方案设计及扩初设计，而施工图设计则交由本地设计院承担。由于本地设计院施工图深度还是与中国传统的定额计价及按实结算的方式相吻合，故其设计深度及质量不能满足准确计量及包干计价的要求，如本地设计院不提供技术规格说明书，不负责如幕墙、弱电等专业工程的详细设计，某些细部设计一定要在业主设备采购后才能开展等，这就给项目的造价控制带来极大的困难（图1）。以下为本地超高层项目普遍存在的造价控制问题：

A. 由于以上的原因，业主无法全面及准确地进行设计方案的经济比较，无法准确地确定项目的估算、概算及目标成本，不能有效地进行成本控制目标的分解及实施限额设计，导致成本目标的可靠性低，限额设计无法得到有效实施；

B. 业主无法编制出准确完整可靠的招标工程量清单，清单项目或描述不清或漏项多，大量的材料设备只能采用暂定价，依赖后期的批价核价审价，无法进行市场的充分竞争；

C. 大量采用开口合同，合同纠纷争议多；

D. 由于本地设计院不参与回标文件的技术分析和询标，大量的技术问题得不

Figure 1. Tall buildings redefine the cityscape (Source: TBA)
图1. 超高层建筑重塑天际线（来源：TBA）

of design options and to decide on an effective cost planning and budget control as well as to establish a realistic design based on the limited budget, which results in a low degree of cost control and ineffective implementation of design;

B. Developers are not able to work out precise and reliable bills of quantities for tendering due to unclear description or even missing items in the existing bills of quantities. Therefore, adoption of prime cost rates is the choice for many materials and equipment in the early stage and the pricing can be only confirmed in a later stage. According to this, competitive market prices could not be obtained by the time of tendering;

C. Due to the design issues and time constraint, there is no choice but to use open-end contracts in most cases and this may cause a lot of potential contract disputes over the course of a project

D. Since Local Design Institutes do not provide technical analyses and evaluation of tenders by the time of the return of tenders, a large number of technical issues are left unsolved and lead to possible disputes and arguments during the construction stage;

E. Most developers are eager to adopt either direct supply contracts (that means materials and equipment are purchased directly by the developers and installation will be carried out by the contractors) or nominated supply contracts (that means the developers nominated the suppliers and fixed the price then the contractors will purchase materials and equipment from that nominated suppliers with the fixed price accordingly) in most of contracts. The number of these contracts varies from a few dozens to a few hundred. As a result, managing such numerous contracts create complex working relationships within the project team and also substantial difficulties in controlling the project program, quality and cost;

F. Lots of design problems are left over from the design stage and are resolved during the construction stage, which causes lots of design modifications, on site records requiring endorsement and approval of technical requirements. As a result, this creates a lot of contract dispute issues and difficulties in contract management.

In light of the aforementioned problems and taking into account of the practical experience of delivering successful super high-rise building projects (Figure 2), please note the following:

1. Due to the complexity of super high-rise building projects, the project team usually comprises the Architect, Design Institute and more than few dozens of professional consultants such as the Traffic Consultant, Structure Consultant, Electrical & Mechanical Consultant, Facade Consultant, Excavation and Lateral Support Designer, Interior Designer, Lift Consultant, Fire Engineering Consultant, Damper Consultant for Vibration, Lighting Consultant, Disaster and Safety Management Consultant, Aerial Assessment Consultant, Seismic Consultant, Anti-terrorist Consultant, LEED Consultant, Sustainability Consultant, BIM Consultant, Risk Management Consultant, Insurance

Figure 2. Shanghai Tower - China's tallest building (Source: RLB)
图2. 上海中心大厦 – 中国最高建筑（来源：利比）

到澄清，导致施工阶段的合同争议和纠纷多；

E. 业主采用大量的甲供合同(指由 业主负责购买的材料及设备合同，安装则由承包商负责)或甲定乙供合同(指由业主确定供应单位及价格，但由承包商负责购买的材料及设备合同)，合同数量少则几十个，多则数百个，导致项目的合同关系相当复杂，极大增加了工程进度、质量和造价控制的难度；

F. 由于众多设计遗留问题延至施 工阶段解决，施工阶段的设计修改、现场签证、技术核定单等多，合同纠纷多，合同管理困 难等。

就如何解决上述问题，笔者结合其众多超高层项目的经验（图2），建议如下：

Figure 3. Two IFC is currently the 2nd tallest building in Hong Kong (Source: TBA)
图3. 国际金融中心二期是目前香港第二高楼（来源：TBA）

Consultant, and so on. Developers should engage the architect, Local Design Institute and professional consultants according to the functional requirements and specialized works involved at the early stage of the project so that they can coordinate with each other and undertake designs that are in line with the developers' aspirations. In the meantime, the responsibilities have to be identified clearly between Local Design Institute and professional consultants, such as the demarcation between Local Design Institute and electrical & mechanical consultant team in terms of electrical & mechanical construction drawings and specifications; the demarcation between Local Design Institute and interior designers with respect to the second iteration of electrical & mechanical designs; the demarcation between landscape designer and landscape construction drawings consultant, etc. Since the design and professional consultants of super high-rise buildings may come from around the world, a clear definition from the outset about the depth requirements of the design outcome document in each design stage is required in order to ensure that all parties can meet the cost control requirements. Based on this, as directed by the architect and the project manager as well as through collaboration with the Local Design Institute and professional consultants, the quantity surveyor can undertake complete cost control during the design stages, including the comparison of design options, estimate, preliminary estimate, cost planning, confirmation of target cost, and ensure that all the design outcome documents would achieve the fixed lump sum price approach.

2. Local Design Institutes do not provide the technical analysis and evaluation of tenders during the tendering stage, in fact, they lack of this kind of relevant experience. In terms of technical complexity, diversity of professionalism, extremely high standards and technical challenges for super high-rise buildings, the developers are recommended to extend the consultancy services of the professional consultants to tendering and construction stages, which includes the technical analysis of all tenders, preparation of tender queries, attending technical interviews, preparation of tender reports, preparation of contract drawings as well as approval of shop drawings and material submissions, etc., during the construction stage. This can pave the way for professional consultants to exercise their professionalism in all stages and to achieve "professional projects delivered by professional teams" (Figure 3). As an aside, during the tendering stage, all the commercial and technical queries can be clarified, competitive bids can be obtained, contract risk could be minimized and lump sum price could be assured. As a result, all such pricing during the tender stage could be controlled.

3. The hundreds of contractors and suppliers involved in super high-rise building projects (Figure 4) in the traditional Chinese contract model – such as contractors for structural and architectural works only, main contractors for construction management, specialized contractors that sign contracts with the client, direct suppliers, parallel contracting structures (where the developer signs contracts with the independent contractors with no main contractor involved, and site management works are the responsibilities of the developer themselves), and direct Suppliers – may not fulfill the management needs of the super high-rise building. Based on the construction method and project

1. 因超高层项目的复杂性，参与项目建设的建筑师、设计院和专业顾问单位达数十家 如建筑师、本地设计院、交通顾问、结构顾问、机电顾问、幕墙顾问、围护设计、精装修设计、电梯顾问、消防技术顾问、阻尼器顾问、泛光照明顾问、安全及防灾顾问、航线评估顾问、地震安全分析顾问、反恐措施顾问、Leed顾问、绿色建筑顾问、BIM顾问、风险管理和保险顾问等。业主应根据超高层项目的业态和项目涉及的专业，聘请建筑师、本地设计院和专业顾问团队，确保所有项目的专业均由设计院或相应的专业团队负责设计，使得所有的设计团队在一开始就得到整合，所有的设计工作能同步开展及得到协调。其中还需要明确界定本地设计院与专业顾问之间的工作界面，如机电顾问与本地设计院的关于机电施工图与机电技术规格说明书的分工，本地设计院与精装修设计单位关于二次机电的设计界面、景观方案设计单位与景观施工图设计单位的分工界面等。由于超高层项目的设计及专业顾问来自全球，故特别还需要从一开始就要明确

Figure 4. Upon completion, Suzhou Zhong Nan Centre will become the third tallest building in the world, as well as the tallest building in China (Source: TBA)
图4. 苏州中南中心竣工后，将成为世界第三高的摩天大楼及中国最高的摩天大楼（来源：TBA）

management characteristics, developers should provide a reasonable and realistic list of tender packages and to take a holistic approach in project design, program and construction management for such developments. The ideal contractual arrangement is a main contract and nominated sub-contracts, which includes specialized nominated sub-contracts. In considering the sole responsibilities of detailed design and quality of works, it is not suggested to separate the supply of materials or equipment from the sub-contract and to be provided by the developers. The main contractor will be held fully responsible for project program and quality control while specialized nominated sub-contracts could be determined by the developer throughout the tendering process and the specialized nominated sub-contractor will sign the sub-contract with the main contractor. The typical contract framework for super high-rise project comprises of pilings and retaining contract, main contract (including excavation, lateral support, structural works, structural steel works for hanging, masonry works, general decoration, external works, coordination and attendance for management of sub-contractors, etc.), structural steel supply sub-contract, curtain wall sub-contract, integrated electrical & mechanical sub-contract, lifts & escalators sub-contract, extra low voltage sub-contract, helipad sub-contract, BMU sub-contract, fire rated doors sub-contract, fitting out sub-contract, external lighting sub-contract, landscaping work sub-contract, damper sub-contract, signage sub-contract, traffic lining sub-contract and so on. The above mentioned contractual arrangement will facilitate the management of project progress and quality control. Owing to the tendering processes for relevant sub-contracts are drawn upon from the complete drawings and technical specification, the strategy of competitive pricing can thus achieve which is in favor of the project (Figure 5).

4. Apart from the architectural and structural works, the nominated sub-contractors should also be responsible for the detailed design of their works like structural steel works, curtain wall, electrical & mechanical, extra low voltage system, fitting out, façade lighting, lifts etc. for super high-rise projects. Generally speaking, the tender

Figure 5. A lot of iconic supertall buildings are designed by internationally renowned architects (Source: RLB)
图5. 很多超高层大楼均由世界著名建筑师所设计（来源：利比）

界定各设计阶段的设计成果文件深度要求，以确保他们所有的设计成果文件能够符合全过程造价控制要求。在此基础上，在建筑师或项目管理单位的统筹下，在本地设计院和专业顾问配合下，测量师顾问才能全面地进行设计阶段的造价控制，包括方案比较、估算、概算、造价规划、成本目标确定，及确保所有的设计成果文件能够满足总价包干的计价模式要求。

2. 因本地设计院不参与招标阶段的技术标书分析及询标，事实上他们也无这一方面的经验，鉴于超高层项目技术的复杂性，专业多样性，标准要求高，技术难度大等特点，业主应延伸专业顾问团队的服务至招标和施工阶段，包括对所有技术回标文件的分析，撰写询标问卷，参加技术询标，编制回标分析报告，制定合同图纸，于施工阶段负责深化图纸审批、物料审批等，使专业顾问能全过程地发挥他们的作用，真正体现专业工程由专业人士负责的理念（图3）。只有这样，招标阶段的所有商务和技术疑问才能得到澄清，投标报价得到充分竞争，合同风险得到控制，包干计价得到保证，招标阶段造价才能得到全面控制。

3. 因超高层项目涉及的材料设备成千上万，参与施工的承包商及供应单位多达百家（图4），中国的传统发包模式，如土建施工+总承包施工管理+专业承包+甲供、平行发包+甲供等，是不能适应超高层项目工程管理需要的。业主应根据超高层项目的施工及工程管理特点，合理地划分标段，建立一个与整个项目设计、开发进度、工程管理等相吻合的合同架构体系，实行总承包加指定分包的合同体系，其中分包工程一般划分至专业工程。考虑到专业分包工程的相对完整性，为体现单一的深化设计及施工质量责任制原则，不宜将分包工程的材料及设备抽出作为甲供。总承包方需要对整个项目的工期和质量负全部的责任，专业分包工程则由业主经招标确定，分包合同则由总承包方与专业分包单位签署。典型的超高层合同架构包括桩基及围护独立工程、总承包工程(含土方开挖、围护工程、土建工程、钢结构吊装工程、砌筑工程、粗装修工程、室外总体工程、为专业分包工程提供协调配合管理服务等)、钢结构供应分包工程、幕墙分包工程、综合机电分包工程、电梯及扶梯分包工程、弱电分包工程、直升机停机坪分包工程、擦窗机分包工

Figure 6. Lotte World Tower in Seoul will become the tallest skyscraper in Korea upon completion (Source: TBA)
图6. 位于首尔的乐天世界大厦，建成后将成为韩国最高的摩天大楼（来源：TBA）

or construction drawings of these works are not detailed and accurate enough for the preparation of bills of quantities. In order to minimize the argument, by using the drawing specification lump sum fixed price model, the developer may provide schedule of rates with indicative quantities to the tenderers for reference, while tenderers may make amendments on the schedule of rates and offer their tender price based on their detailed design and holistic design as well as bearing the risk of the inaccuracy of the schedule of rates (Figure 6). This will be a significant reduction of risks to the developers in cost control when compared with the re-measurement approach.

5. Super high-rise building projects involved lots of materials and equipment, although better cost and quality control may be achieved to a certain extent if local developer avoids direct supply contracts for the purchasing of materials. It will inevitably increase the project management cost of the developer and require lots of manpower as well, such as the additional staff that will be needed to deal with the tendering and daily management of the materials provided by themselves. In addition, contract-related risk such as repetition or omission, disputes over quality such as the responsibilities of the failure for testing and commissioning, etc. For instance, if the material provided by the developer cannot be delivered to the construction site on time, the developer has to bear for the loss caused by the idling of the labor force and extended project duration. This causes additional responsibility imposed to the developer. Therefore, the number of such direct supply contracts for materials and equipment to be provided by the developer should be reduced to the minimum or even removed as an arrangement (Figure 7).

6. According to the local practice, the formation of variation during the construction stage is diversified, including design revisions as requested by the developer, design revisions as

程、防火门分包工程、精装修分包工程、泛光照明分包工程、景观绿化分包工程、阻尼器分包工程、标志标识分包工程、交通划线分包工程等。上述合同体系有利于项目的进度、质量的控制，由于各专业分包工程均在完整的图纸及技术规范基础上通过招标竞标确定，故也有利于项目的充分竞标（图5）。

4. 除土建工程外，超高层项目的钢结构工程、幕墙工程、机电工程、弱电工程、精装修工程、泛光照明工程、电梯工程等均需要承包商负责深化设计，通常这些工程的招标图或施工图无法达到准确编制工程量清单的深度要求，为减少争议，可以采用招标图纸加技术规范包干计价的合同模式，即业主提供参考工程量清单，由投标单位结合其深化设计和综合管线设计考虑对工程量清单的修改及报价，并承担清单数量准确与否的风险（图6）。这样可大幅度降低按实结算模式给业主带来的造价控制风险。

5. 超高层项目的材料和设备数量多达成千上万，本地业主的甲供合同模式虽然可以降低成本、控制质量，但势必增加业主工程管理的成本，业主需要投入大量的人员处理甲供材料设备的招标和日常管理；增大了合同界面风险，如合同范围的重复或遗漏；引起质量责任的纠纷，如系统调试不合格责任的界定等；增加了业主的额外责任，如甲供材料设备不能按时到场，业主要承担承包商窝工的损失和工期延误赔偿等。因此，应尽可能地减少甲供或取消甲供（图7）。

Figure 7. The 530m supertall Pertamina Energy Tower, will be the tallest building in Indonesia. (Source: TBA)
图7. 530米高的Pertamina Energy Tower 将成为印度尼西亚雅加达的第一高楼（来源：TBA）

proposed by the Design Institute, the contractor's technical endorsement, the developer's on-site approval, etc. Design changes proposed by the Design Institute mainly focuses on incorrect designs; technical endorsement is generally proposed by the contractor on the basis of poor buildability of design drawings or for a better construction method, while in some cases it may be suggested by the Design Institute in order to rectify design errors. In most cases, on-site approval is drafted by the contractor, which is usually misleading and quantities of work done inaccurate. Therefore, it is very important for the local developer to consider working out a complete set of cost control processes during the construction stage in order to tie in with the international common practice. By experience, it is advisable to utilize the change control system under the architect, including the systems for evaluation of draft variations, instructions, etc (Figure 8).

7. Local cost control is based on a segmented management structure. For instance, cost estimates and cost plans are conducted by the Local Design Institute; tendering by the tender agent; interim payment during construction stage and assessment of variations are to be approved by the construction supervision unit or auditor; and settlement of final account by settlement audit unit. Since a complete cost management is breaking down manually into different divisions, it therefore creates chaos and often goes over budget. By experience, super high-rise building developers should engage quantity surveyors to provide a full and complete cost management process, that means the cost management process in every stage should be based on the principle of "contract sums±accumulated variation cost should be less than the budget control cost," and the final contract sums can also be controlled within the set budget control cost finally (Figure 9).

8. Based on practical experience accumulated from numerous projects, most super high-rise building developers will engage professional consultant teams. However, the staff of the local developers may not have sufficient experience to work together with such professional consultants or even do know how to instruct them, thus causing inefficiency on

6. 按本地惯例，施工阶段构成工程变更的内容包括业主要求的设计变更、设计院提出的设计修改通知、承包方的技术核定单、业主的现场签证等，形式多样、内容众多。其中设计院的设计修改主要是设计错误和前期考虑不周到引致，技术核定单主要是承包商以设计图纸可建造性差以及便于施工为由而提出，当然也存在设计院以技术核定单的方式修正其设计错误的情况，现场签证则多数情况下由承包商起草，实践中经常发现内容失真、工程量虚报和资料不全的情况。因此建立一套按国际惯例进行施工阶段造价控制的流程是本地业主需要考虑的。按笔者的经验，国际建筑师负责制下的变更控制体系可以直接借鉴，包括设计变更的预评估制度、工程指令制度等（图8）。

7. 本地造价控制采用的是分段式的管 理模式，如估算和概算由设计院负责，工程招标由招标代理负责，施 工阶段付款及变更评估由监理或跟 踪审计负责，结算由结算审价单位负责等，全过程造价控制被人为地分解，结果是普遍导致结算超预算，预算超概算的失控情况。结合笔者的经验，超高层项目业主应聘请工料测量师顾问，实行造价的全过程控制，即围绕以“合同价±累计变更≤成本控制目标”开展各阶段的造价控制工作，最终将结算价控制在成本目标范围内（图9）。

8. 根据众多项目实践经验，许多超高层项目业主多多少少都会聘请一些专业顾问团队，但由于本地业主人员

Figure 8. The 300-meter-tall Eureka Tower is the tallest building in Melbourne, Australia (Source: TBA)
图8. 300米高的Eureka Tower 为澳大利亚墨尔本的第一高楼（来源：TBA）

Figure 9. UAE is home to many famous skyscrapers (Source: TBA)
图9. 阿拉伯联合酋长国拥有多幢摩天大楼（来源：TBA）

Figure 10. London's skyline is set for further change with a number of tall buildings in the pipeline (Source: TBA)
图10. 伦敦的天际线正在不断变化（来源：TBA）

behalf of the professional consultants and ineffective cost management implementation. Hence, the professional consultant teams must assist the developers to create a harmonious contractual relationship – including the setting up of working procedures, management systems – and strengthen training in design, construction, budget, contract management to the specialized staff of the developer. At the same time, professional consultant teams should take the initiative to proactively exchange ideas with the developers and strive to provide better services than the Local Design Institute in a conscientious, professional and dedicated way (Figure 10). All in all, a well-established cost management system, a close collaboration among different parties and the expertise services provided by design and consultant teams are the major prerequisites for a successful super high-rise building project.

As a conclusion, taking into account of the abovementioned factors for the design, tendering and construction of super high-rise building, an effective cost management can be fully exercised, playing an indispensable role from the inception to completion of super high-rise building projects.

缺少使用这些顾问的经验，他们往往不知道如何使用这些顾问，当然也就会无法充分发挥这些顾问的作用，导致全过程造价控制不能有效地落实。因此，专业顾问团队有必要协助业主建立一个与使用专业顾问团队相适应的内部管理环境，包括工作流程、管理制度等，并且通过加强对业主内部设计、工程、预算及合同管理专业人员的培训来减少与专业顾问团队的磨合，同时专业顾问团队还应主动与业主相关方交流沟通，更应以远超本地设计院的严谨、认真、执业、敬业的工作态度服务业主（图10）。而上述制度的建立、各方之间密切的合作、设计及顾问团队专业的服务是全过程造价控制的必要保证。

抓住了以上几个环节，超高层项目的设计、招标、施工就能有条不紊的进行，设计阶段的估算、概算、造价规划、目标成本、限额设计、合约规划、现金流分析，招标阶段的工程量清单、招标文件、合同条款、专用条款、回标分析、询标、获得有竞争力的合同总价，施工阶段的合同管理、变更的动态控制、财务报告，以及竣工结算阶段的竣工结算等全过程造价控制的每一个环节就能从根本上落到实处，项目的成本目标得到有效控制。