

Cost overrun causes related to the design phase in the chinese construction industry

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Abstract. At present, the cost management of the construction project mainly focuses on the construction stages, but pay less attention to the design phase. It is really important to reasonably understand and strengthen the design stage cost construction management. We reviewed the literatures on the essentials of design stage cost management and cost overrun causes related to the stage in both worldwide projects as well as the Chinese construction projects. Then a semistructured interview is chosen to offer comparison and deep exploration to the points. The importance and necessities of controlling construction cost in design stage are analyzed. Potential and suggested methods and ways of construction cost management in the design phase are also put forward.

Key words. Chinese construction industry, design stage, cost overruns, cost management and control.

1. Introduction

In recent years, the number of real-estate development and construction projects has increased dramatically in China (Wang, 2014). However, many problems have emerged during the development of construction projects; among which, the most concern is the cost overrun (Smith, 2016). This common phenomenon occurs in many areas in the world, especially in developing countries. According to Durdye (2012), most construction projects in developing countries are characterized by cost overruns. Moreover, most of the property development projects in these countries need investment outlays to control cost. In the process of development, cost control in different stages has different characters, roles as well as focuses (Cheng, 2014). However, during the past few decades, the construction industry in China has been indifferent to the cost management in design stage, which leads to the poor quality of design, even worse, cost overruns in the long term. The developers concern more about construction budget in drawings, final cost and the cost of Project Set-

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tled Accounts. To some extent, these cost management methods can reduce cost overruns, yet the effectiveness is not as significant as that of the cost management in design stage (Chan, 1997). On the other hand, although both consultants and clients in China have learnt a lot to improve their profession, they still lack of cost management skills in early stages of the project, such as feasibility stage and design stage. This may be because the construction projects in China are fast developed and conducted, normally the early stages last less than three months (Li, 2009). In this case, the clients and contractors would focus more on the construction stage rather than the early stages. In fact, although the design cost only accounts for small part of the construction cost in most construction projects, it can be a big influence on controlling cost overruns. Therefore, the cost management of design stage is essential and inevitable and the clients and cost managers should devote much attention to control management in this phase (Kinney and Raiborn, 2008).

The quality of the engineering design is not only related to the number of one-time investment in construction projects (Li et al. 2013), but also affects the full play of economic benefits after delivery, such as usage fees, maintenance fees and recycling fees etc. It is also related to major cost-overrun issues, such as the irrational use of limited resources, uncertainty as well as risks, etc.

The construction process is a productive and consumptive process with a long period and a large number of money (Williams and Gong, 2014). For a long time, Chinese construction industry has generally ignored the project cost control in the pre-construction stage and focused on construction budget and final accounts. In fact, the effect of cost management is very slight when the project goes into the construction phase. Even though it is also effective, construction stage cost management only plays a minimal role in investment. As a matter of fact, controlling construction cost from the design stage means seizing the key aspects of the project cost control, and it will yield twofold results with half the effort (Li, 2009). The control of project cost is conducted throughout the whole process of the project.

The designing cost usually accounts for only 2% to 4% of the construction cost, but it can have 75% of the influence on the project cost (Ling and Li, 2012). Furthermore, designing project is a process which makes a comprehensive planning for construction projects and detailed description of the implementation intent (Bacon et al., 1996). Also, it is the basis for the project construction, and the key to dealing with technology and economy as well as the process to realize the combination of technology and economy (Cokins, 2002). Specifically, the preliminary design largely determines the size, structure, standards and the functions of the construction. Then it forms into the design cost estimates and determines the maximum amount of investment. After the completion of construction drawings, the construction budget can be prepared and the construction cost can be estimated accurately. Therefore, whether the design quality has reached the national standard or requirements is important, because this does not only concern the number of investment in construction projects, but also affect the full play of economic benefits after delivery. The cost management in the design phase is the first round of controlling the overall project cost. Obviously, the design stage is the key to influencing and controlling the construction cost (Lu et al., 2017).

Many factors influence cost overruns in different projects and countries have been identified. However, there are few studies on causes of cost overrun related to the design and their effects on the construction cost in China. As the cost management in design stage plays a significant role in the successful delivery of projects, the importance of identifying the design-stage factors that may lead to cost overruns in construction projects is self-evident (Chen et al., 2015). The previous review of the causes of cost overrun associated with design stage is essential to understand the importance of design stage cost management. Through a more specialized literature review, we found that Bassioni et al. (2013) did a similar study on cost overrun causes related to the design phase in the Egyptian construction industry. In the study of Bassioni et al. (2013), a list of cost overrun causes related to the design phase was produced through a comprehensive literature review. Then the main causes were adapted to the Egyptian construction industry through semi-structured interviews. At last, the resultant list was submitted to a questionnaire survey for the impact and frequency quantitative evaluation. The final findings and the key factors concluded through the questionnaire are summarized by Bassioni et al. (2013) as follows:

- ‘Occurrence of design changes, variations, or additional work by the designers or client’. The factor turned out to be the most important one regarding the overall results since they can influence the project’s estimated budget and time. Accordingly, cost overruns, delays and subsequent claims may arise in the construction stage due to reworks and changes.
- ‘Improper estimation of construction cost and period’. Improper estimation ranked as the second most important factor of cost overrun causes relative to the design stage. From the perspective of the project cost managers and the clients, an accurate estimation of construction cost and time on the project is essential to the following work (Magnussen and Olsson, 2006).
- ‘Lack of details or contradiction in design, design errors or mistakes, and conflict between design drawings and specifications’ were also identified as a high relative importance factor. However, the contractors’ results showed a different opinion with the client/consultants due to the design process is mainly under the clients’ and project managers’ responsibility.
- ‘Lack of early contractor’s participation, and coordination between the contractor and the designers’. Except for the architects, both the project manager and the clients ranked this factor as a high important issue. The results showed a conflicting opinion between the main participants because the designers are believed to be responsible for the integration of various parties in the design process (Sullivan et al., 2017). Also, if contractor participates earlier in design, many problems during construction stage may be avoided in advance. Besides, without communication and coordination between different parties, conflicts and claims can easily lead to cost overruns
- ‘The architects and designers think less of cost and economy’. It is common for architects to focus on the design rather than the cost, but the construction

is not just about design and building. As a result, this factor is regarded as one of the major causes related to the design phase

- ‘Selection of inappropriate construction contractors or companies’ recorded as the lowest important factor among the research’s results. However, if a proper and competent contractor is selected, the architects, owners, and project managers may increase the profit of the building in an avoidable way.

Although the Egyptian construction industry cannot represent that of China, we can still study the findings and adapt it to structure the interviews in the Chinese construction industry. Moreover, the importance of design stage cost management has been strongly recommended by a few researchers who have studied cost management in the Chinese industry because of its potential positive effect on the construction cost. So all the identified cost overrun causes related to the design phase in the Chinese construction industry and the importance of design stage management will be deeply understood through the proposed interview.

2. Methodology

2.1. *Study design*

With the purpose of identifying the causes of cost overruns related to the design stage and then understanding the importance of the design stage cost management in China, the study will be completed by mixed methods. Since the study is limited to the projects in the Chinese construction industry, the national context and construction situation should also be taken into account. A semi-structured interview has been selected to get opinions of associated practitioners who have working experiences in cost management and Chinese construction projects. Then, the interview will be piloted and pre-tested many times before it is sent to participants. In the end, we tried to seek out possible ways through the interviewees’ opinion to enhance the design stage cost management in China.

2.2. *Data collection and the interview*

With regard to data collection methods, we intend to interview practitioners and professionals who have cost management working experience and are currently working or in the Chinese construction industry. On the one hand, it would be better to extract direct opinions on design-stage cost management from interviewees so as to fully support subsequent analysis on the importance of design stage cost management in Chinese construction industry. On the other hand, in order to summarize and compare the subsequent findings, the study needs the interviewees to focus on answering questions as much as possible. Thus, the semi-structured interview is supposed to be the most proper method for this study (Grix, 2010).

Creswell (1994) indicated that common questions in qualitative research should cover two at least levels, for example, the main question goes with around four specific sub-questions. Thus, it is important to first think of the applicable main

questions for conducting successful interviews. We extracted key causes and necessities, which are associated with design stage cost management in China. All these chapters guide the research to formulate appropriate main questions for the interview. Then, the following section will describe in detail how the interviewees are selected.

3. Cost overrun causes related to the design phase

3.1. Causes extracted from the clients' opinion

(1) The designers don't have strong economic concepts.

According to the interview results, the interviewees who serve as clients both stated that the designers lack economic concepts and think less of the cost. The designers concern more about the reliability of project structures rather than attach design to cost and value.

They keep the thoughts of emphasizing technology and ignoring economy in their minds, which separates the technology from the economy. [Client (Interviewee D)]

Just as many foreign experts point out, whether as to technical ability, working ability or knowledge range, Chinese engineering and technical staff can keep up with foreign counterparts. However, most Chinese designers lack economic awareness and down conservative designing thoughts. [Client (Interviewee C)]

This is mainly related to the current system of the design institutes. Design institutes lack the initiative to control the cost of in the design stage as well as the budgetary restraint mechanism.

Design institutes may try to do the project budget in the design phase, even down to the estimation. But they cannot control the project cost fundamentally due to the lack of constraints of the project cost indicators [Client (Interviewee C)]

Under most circumstances, the designers consider reducing project budget as the responsibility of cost manager; while the financial and cost manager break away from the processes of engineering design and the links, counting dead accounts rigidly. The cause is consistent with the fifth finding in the temple stated above.

(2) There are conflicts between design drawings and specifications

The designing scope and standards are decided by the requirements of usage and technical progress. It should be said that the satisfaction standard of the construction party is the reasonable designing standard. It is in conformity with the technical standards and specifications. But in the current engineering design, the designers often ignore these.

The designers consent to the unauthorized expansion of designing scope,

and they set the designing standards higher than construction requirements. [Client (Interviewee C)]

Regardless of the actual needs and investment constraint of the construction party many designs consent to the unauthorized expansion of building scope and set the extreme standards higher than construction requirements.

They get used to pursuing perfection, giving full play to their artistic imagination and displaying their design talents. [Client (Interviewee D)]

The outcome is also consonant with the third cause ‘Lack of details or contradiction in design, design errors or mistakes, and conflict between design drawings and specifications’.

(3) The occurrence of design errors and changes is frequent

The factor turned out to be the most important one regarding the overall results since they can influence the project’s estimated budget and time.

Design changes and variation are very big problems and can easily lead to cost overruns [Client (Interviewee C)]

They can affect the project’s estimated budget and time for construction due to reworks and delays and subsequent claims. [Client (Interviewee D)]

Accordingly cost overruns, delays and subsequent claims may arise in the construction stage due to reworks and changes and this can explain why not only the clients but also the consultants state the factor.

3.2. Causes extracted from the consultants’ opinion

With respect to the consultant’s opinion, a few different cost overrun causes related to design phase are mentioned, but the factor that ‘occurrence of design errors and variations’ is also pointed out as the clients. Other different causes are extracted as follows:

(1) The plans of design are normally illconsidered

Generally, the plans of design in Chinese construction are less considered as the building need to be produced in very limited time. Thus, the architects have to finish the design quickly without thinking of the designing plans.

The plans of design lack the comparison and optimization of the technical economy, and the designs are generally conservative.[Consultant (Interviewee B)]

Both the artistic beauty and structural safety determine the quality of the project; however, the rationality of cost should be emphasized as well. Yet, in the design stage of the project, the situation is opposite.

Currently, engineering designs lay more emphasis on the beauty and safety, less on the reasonable decision and consideration of the project cost [Consultant (Interviewee A)]

Therefore, many issues such as the layout form, the determination of the depth and width, the choice of facade, the determination of floor height and number, the selection of basic types and the selection of structural plans, are all problematic with the separation of technology from economy. Also, the designers lack understanding of the subsequent cost implications of what included in the design and this is an important factor in the design stage that can easily result in cost overruns in the following phases. This finding is partly consistent with one the findings derived from previous literature review. It showed that the plans of design are normally ill-considered and it is regarded as an important cost-overrun cause related to the design phase.

(2) The preliminary cost estimate in the design stage cannot get enough attention

A strict censorship system has not been established to monitor the preliminary cost estimate in the design stage so the quality of the preliminary estimate and working drawing estimate is poor

There are disjoints among the investment estimates of construction projects, preliminary design estimates, and construction drawing budget. [Consultant (Interviewee A)]

Besides, cost managers generally do not lay emphasis on the role of economic staff in the designing process and lack measures to encourage the skilled personnel to emphasize the economy of designs.

Due to the costs, some construction firms even cancel the preliminary budget staff in the design stage. They also lack a strict censorship system for the project preliminary budget, and there is no continuity as for the determination and control of the project cost in various stages. [Consultant (Interviewee B)]

Specifically, the investment estimation in theory is the control objective of project cost during the design selection and optimization, while the preliminary estimate is the control objective of project cost during the preliminary designing phase and technical designing phase. Besides, the construction drawing budget shall be the control objective of project cost during the design stage. As a result, each step is equipped with separate objective of controlling project cost and the actual cost in the next stage should not surpass the former control objective. However, in the actual design stage, it cannot reflect the control requirements of designs in terms of cost in various stages, as well as the relationship of step-by-step control. The result is consistent with the second factor 'Improper estimation of construction cost and period' in the template stated above.

Overall, by comparing the consultants' opinion with the clients' opinion, five cost overrun causes related to the design phase are identified, two from the clients 'the designers' lacking of strong economic concepts' and 'conflicts between design drawings and specifications'; two from the consultants 'ill-considered plans of design' and 'lacking attention on the preliminary cost estimate'; one from both the client and the consultants 'occurrence of design errors and changes'. As a matter of fact,

all the identified causes are consistent with the ones in the template. Furthermore, through comparing the findings with the literature review, it can demonstrate that the importance of design stage cost management has been strongly recommended by industry professionals who have experiences in cost management in the Chinese construction industry. Although the cost overrun causes related to design phase in China are not identical to the factors in the stated template, their potential effect on the construction cost still are inevitable, which are helpful in deeply understanding the of cost management in the design stage.

4. Essentials of cost management in the design stage

4.1. Clients' opinion of the design stage cost management

Both the two senior managers confirm that the design phase plays a key role in controlling the construction cost.

Designing plays a decisive role in the construction period, project cost, construction quality and the expected benefits to be achieved after completion, and it is the key to controlling project cost. [Client (Interviewee D)]

This is because the design is a process of comprehensive arrangements for the implementation of the proposed projects in the technical and economic aspects. Also, it is also a process of planning and designing engineering projects. Through establishing a healthy cost controlling responsibility system for the cost management and determining the project cost reasonably,

We can achieve the purpose of improving the economic benefits and saving funds for engineering construction ultimately. [Client (Interviewee C)]

The cost management in the design stage should be not only responsible for the technical feasibility of the project undertaken, but also for the rationality of the project cost in the undertaken projects. As a result, the importance of design stage management is proved.

4.2. Consultants' opinion of the design stage cost management

The conceptual design largely determines the scale, programs, structure, building standards and the usage of construction project. It forms a design estimate to determine the maximum amount of the project cost. After completing the design of construction drawing, its budget can be worked out and we can calculate the project cost more accurately.

Although the designing fee only takes up about 1% of the total investment, the possibility of affecting the project investment may reach 75% to 95% under the right decision in the preliminary designing phase. In

the phase of technical design, the possibility of designing affecting the project investment reaches 35% to 75% [Client (Interviewee C)]

It can be seen that the design stage is the key to influencing and controlling the following construction budget and it plays a decisive role in reducing the project cost.

In the phase of construction drawing, the possibility of designing affecting the project investment reaches 5% to 35%. Only by checking on the project cost strictly before the completion of the design and the non-delivery of the design drawings, can we build a good foundation for the overall project control.[Client (Interviewee D)]

Thus, the technologically-advanced, economical and rational design plays an important role in shortening the duration of the project, saving investment and improving efficiency. Similarly, the design stage is the key to determining and controlling the project cost as the design budget is the basis for the cost control at later stages.

5. Suggested ways to improve design phase cost management

Since the importance of cost management in the design stage has been identified and expressed by the interviewees, the following part intends to seek out ways to enhance design stage cost management in Chinese construction projects by learning from experienced professionals through interviews.

(1) Strengthening the economic awareness of design companies and designers

The preliminary design largely determines the construction scale, structure, building standards and usage. Then, it develops into the preliminary estimate and determines the maximum limit of investment. After completing the construction drawing design, the project cost can be estimated appropriately through the construction drawing budget. Thus, if the design firms or designers only yearn for security and appearance rather than the cost, it may result in many problems.

Such as the fat beams, thick columns, deep foundations, ultra tendons, large cross-section and arbitrary raising of concrete strength and the raising of the project cost in the engineering design.[Client (Interviewee C)]

The design firms can deal with the dialectical and unified relationship between technology and economy by familiarizing the designers with the knowledge of construction cost.

Therefore, if a designer truly wants to realize the organic integration of technology and economy, he must be familiar with the fixed budget and fixed costs in his field, and understand some knowledge of the project cost. [Client (Interviewee C)]

In the actual operation, when the owners sign the commissioned contract with designing units, some relevant provisions of reward and punishment could be included.

The owners should offer wages to these designers for their labour. They can also extract a certain part of investment savings from optimized designs to offer rewards. [Consultant (Interviewee A)]

In this case, it can mobilize the initiative of designers to pay attention to project cost actively. Under the premise of ensuring safety and functions, design companies can save project investment through new technologies and materials within the approved limits.

(2) Choosing the ‘best design’ through tender and evaluation

Under the premise of the same functions and anti-seismic requirements, the project cost should be located in a reasonable range. A reasonable designing plan plays an important role in shortening the construction period, effectively controlling project cost and improving economic efficiency.

In theory, the more complicated the drawings are, the higher the cost will be. If the cost of design exceeds the reasonable limits, the designing drawings may lead to cost overruns. [Consultant (Interviewee A)]

Therefore, in order to enable designers to carry out the plan well, the client can introduce the competition mechanism into the design bidding, which can prompt design companies to enhance competitive awareness. Through competition, the designing plan will stand out with good function, low project cost, high efficiency and rational technique and economy.

The same designing task can own a variety of different designing plans. We should select the most satisfactory one from those available. [Client (Interviewee D)]

This is also conducive to breaking the blockade among regions, sectors, and industries. Then a unified and open architectural design market may be formed. The design companies win their shares in the market with their own qualifications, strength, optimized design and the most reasonable cost. It makes the project cost get controlled more effectively in the critical design phase.

(3) Introducing supervising mechanism into the designing stage

Supervision in the design stage that has the largest possibility of influencing the investment in the designing phase, experiences a slow implementation process.

At present, the construction supervision in China mainly happens in the construction phase. [Consultant (Interviewee A)]

As a technical product, design and the quality of it cannot get technical supervision or evaluated. In order to meet the functional and safety requirements within investment permission and achieve aesthetics coinciding with the times, the supervision mechanism can be introduced to the design phase

The owners should carry out supervision system in the designing phase. [Consultant (Interviewee B)]

The whole process of supervision management can avoid or reduce mistakes/errors in the designing process. Thus, it can improve the quality of design and effectively control the project cost.

6. Conclusions

The design stage is responsible for many critical decisions and many causes of cost overrun are related to this phase. However, most of the studies have neglected the importance of cost management and budget control in such stage. As a result, this study aims to understand the importance of design stage cost control in Chinese construction industry. After the importance of design stage cost management is emphasized and understood, construction companies could then take actions to enhance their design stage cost management and to improve their cost management strategies from the start of the design stage.

We did the interview and analyzed the data of the interview. Through comparing the consultants' opinion and the clients' opinion, five cost overrun causes related to the design phase were identified, two from the clients 'the designers lacking of strong economic concepts' and 'conflicts between design drawings and specifications'; two from the consultants 'ill-considered plans of design' and 'lacking attention on the preliminary cost estimate'; one from both the client and the consultants 'occurrence of design errors and changes'. Although the cost overrun causes related to design phase in China were not identical to the factors in the stated template, they were still useful in deeply understanding the of cost management in the design stage. Afterwards, through comparing the interview findings with the literature review, the outcome demonstrated that the importance of design stage cost management was strongly stressed by the interviewees. Furthermore, potential ways to enhance design stage cost management and budget control in construction projects were also attained from this study.

The final result showed that good design stage cost management can not only bring about various benefits to the project, but also less likelihood of cost-overrun causes associated with this phase. Moreover, cost management methods in design may result in reducing occurrence of cost overruns in the following stage.

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