Research on the optimization of quota design in real estate

Chunling Sun, Susu Ma, Weichao Zhong
Tianjin University of Technology, TianJin 300384, China
hyscl@263.net

Abstract. Quota design is one of the effective methods of cost control in real estate development project and widely used in the current real estate development project to control the engineering construction cost, but quota design have many deficiencies in design process. For this purpose, this paper put forward a method to achieve investment control of real estate development project, which combine quota design and value engineering(VE) at the stage of design. Specifically, it’s an optimizing for the structure of quota design. At first, determine the design limits by investment estimate value, then using VE to carry on initial allocation of design limits and gain the functional target cost, finally, consider the whole life cycle cost (LCC) and operational problem in practical application to finish complex correction for the functional target cost. The improved process can control the project cost more effectively. It not only can control investment in a certain range, but also make the project realize maximum value within investment.

1. Introduction
Years of practice tell us, quota design has many defects although it is popular and plays a significant role in cost control. Real estate projects more obtain land by auction, makes it hard to roughly determine the total cost in the feasibility study stage. Traditional quota design theory do not given a specific method and operational process about determinate quota design value and distribution of the quota design. Despite the scientific quota design focus on the economic benefits of projects, but in practice, designers usually only care about rewards and punishments, and then decreased the economic benefits of the project persistently. Quota design mainly consider the whole construction process of the project and not considering the whole life cycle [1]. The result conflict with cost control with quota design. VE is one of the effective methods to control the cost. It take whole life cycle into account, thus have an effect on improving economic benefit. In short, using VE to optimize quota design can make up for its inadequacy, give full play to the role of it, conducive to the normal operation of the entire real estate market and activate the market.

Through the literature research found that the current quota design research mostly about summary of experience, some of the quota-design-related managers also put forward some views on it: its implementation is difficult, the effect of implementation is not good, only large real estate development enterprises have the ability to practice and relevant indicators should be accurate and so on. It can be seen that the quota design still have many problems in the implementation in China's real estate industry. Therefore, the purpose of this paper is to analyze the problem of quota design in practice, given the optimization plan, to solve the problem of it in cost control. So that make the quota design in the real estate project can be better to implement and promote.

2. Feasibility analysis of value engineering optimize quota design
Quota design is widely applying to the design stage of various construction projects, which is an effective method to control investment [2]. Compared with the general construction projects, real estate
development projects pay more attention to economic benefits. The function is relatively simple and the project source is single. All of those determines quota design for cost control on real estate development project is more simple and effective. Quota design is a typical pre-control means. This reversed the usual post-event control pattern in the construction market.

What the nature of VE is reduce the loss of resources cost in the prerequisite of meeting the functional requirements within owners or users and object of study [3]. VE strive to realize the functional requirements, technologically advanced and feasible and a reasonable economic efficiency within a good investment control.

Applying VE for quota design can effectively analyse the relationship between the function and cost of the VE research object in different design schemes, and form a good cooperation with designers and economic managers, and then make this design technically feasible and economically sound. So that both meet the functional requirements, but also to the dynamic control of the cost, making the investment efficiency is improved. The implementation of quota design, can make a well-bedded plan within the established investment limits, meanwhile, add full life cycle cost and function analysis may solve the irrational distribution of investment quotas. All of this will conducive to the implementation of quota design.

For the irrational allocation of investment quotas, the introduction of VE theory can be based on the analysis of the cost and function of the life cycle when the initial investment amount is decomposed, the functional value coefficient of each function that affects the allocation of investment Will be able to achieve the cost and function of dialectical unity, better cost control, which is conducive to the implementation of quota design.

3. New ideas and methods of value engineering to optimize the quota design

In order to improve the quota design, make up the lack of it, this paper will try to establish a scientific, rational and operational method to optimize the quota design through VE from the reasonable determination of the design limit and the scientific allocation of quotas. The process of VE optimization quota design is shown in Figure 3.1.

3.1. Determine the project function

For the real estate development project, in order to improve the applicability, the function model established in this paper will be based on the relevant provisions of GB / T 50362-2005, sometimes may carry out some appropriate adjustment when used in the actual project. Through the literature review, expert opinion and the real estate function analysis, this paper divide real estate project function index system into five primary indicators and numbers of secondary indicators (see Figure 3.2).
Reference to GBT50362-2005 of China, this model make the real estate development project as target layer in analytic hierarchy process. Design limit not only took into account the owners’ needs, but also be in line with construction dimension, construction standards, social development, technological development, occupational health and environmental safety[4]. So the real estate development project is decomposed into five functions cover use performance, aesthetic performance, safety performance, technical and economic benefits and green benefits of the five functions, and as an target layer.

Determine the functional indicators to facilitate the determination of criterion layer. Only do better on Reasonable choice of indicators, establishing an order of priorities, and remove redundant functions the efficiency and accuracy of analysis can be improved[5]. Through the ABC classification to determine six indicators of use performance; there have three main indicators of aesthetic performance through research; the main indicators of the safety performance have four by reviewing the literature; technical and economic benefits covers three indicators considering some helpful measures for it during construction; this model select four indicators for green benefit on account of the concept of sustainable development win great popular support and more highly focused.

3.2. Necessary correction and adjustment

3.2.1. Collecting the technical parameters of the similar real estate projects. In the actual analysis process, similar real estate projects in the structure, materials and other aspects of different should be noticed, and not treat different things as the same. We can get a scope proportion of total cost and branch engineering costs from standard difference and confidence interval.

3.2.2. Comprehensive correction of functional target cost. In order to enhance the accuracy of quota design, give full play to the advantages of VE in cost control. There need do a further amend for the preliminary distribution of design limit, including Construction costs, operation and maintenance costs and life cycle cost correction. The correction coefficient of this three aspects is K1, K2 and K3 in turn. The correction coefficients K1 and K2 are based on the feasibility of the method in practical operation. The specific figure are determined according to the actual project profile, K1+K2=1.

4. Applied case

4.1. Project profile

A real estate development company plan building a residential district. The land is flat, there have convenient traffic and good infrastructures. East of the residential district is middle and primary schools, west is urban planning road, south is business-street and north is hospital. It’s planning as "green warm and civilized community." There is about 45,000.00 square meters land to plan, the construction area is about 150000.00 square meters, floor area ratio is 3.3 and greening rate reach 30%, residential customers is 1200. The residential building divided over-ground part with 25 or 26 floors and underground part with 1 floor. It adopt pitched roofs at the 26th floor. The underground part is reserved room for equipment. 1th floor have 4.5meters high, 2th -25th floor is 3.6 meters, 26th is 3.9meters, and the basement floors be determined by the embedded depth of foundation. Indoor and outdoor height
difference is 600 millimeters. In this area, the engineering made 7 degrees anti-Seismic design, site classification is II, basic wind pressure select 0.5k N/m (reference 50 years wind pressure of return period), the ground roughness is B. The branch engineering of this project include structural engineering, architectural ornament Engineering, air-conditioning and heating engineering, plumbing work, weak current engineering, heavy current engineering, fire fight engineering, elevator engineering (all showed by E1,E2,E3,E4,E5,E6,E7,E8 in next tables respectively).

4.2. Case study of optimized quota design

4.2.1. Determine the design limit and select the project function. Using feasibility study report and investment estimate to determine the design limit. This project’s investment estimate is about 400 million according to this method. The project function according to figure 3.2.

4.2.2. Primary distribute design limit. Reference the project function, we got importance of index layer and criterion layer according to do a questionnaire survey of functional importance to residents in the surrounding area and processing and analysis of questionnaire data. Specific number see weight Ai and weight Bi in table 4.1.

| Function                          | Evaluation Index | Branch engineering | Gross score |
|-----------------------------------|------------------|---------------------|-------------|
| Name                              | Name             | B1                  | E1  | E2  | E3  | E4  | E5  | E6  | E7  | E8  |          |
| Use performance                   | Use space        | 2.0                 | 70  | 20  | 0   | 0   | 0   | 0   | 10  | 0   | 100       |
|                                  | Ventilation and lighting | 1.5                 | 50  | 15  | 0   | 20  | 0   | 10  | 0   | 0   | 100       |
|                                  | Equipment condition | 2.0                 | 25  | 10  | 10  | 10  | 15  | 10  | 10  | 0   | 100       |
|                                  | Sound insulation and heating | 1.5                 | 70  | 20  | 0   | 0   | 0   | 0   | 0   | 0   | 100       |
|                                  | Illumination     | 2.0                 | 0   | 0   | 0   | 0   | 0   | 0   | 100 | 0   | 100       |
|                                  | Information Sharing | 1.0                 | 0   | 0   | 0   | 0   | 100 | 0   | 0   | 0   | 100       |
| Aesthetic performance            | Appearance       | 3.0                 | 60  | 40  | 0   | 0   | 0   | 0   | 0   | 0   | 100       |
|                                  | Interior decoration | 3.0                 | 10  | 90  | 0   | 0   | 0   | 0   | 0   | 0   | 100       |
|                                  | Exterior decoration | 4.0                 | 0   | 100 | 0   | 0   | 0   | 0   | 0   | 0   | 100       |
| Safety performance               | Firm              | 3.0                 | 100 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 100       |
|                                  | Practicality      | 3.0                 | 65  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 100       |
|                                  | Disaster prevention Performance | 1.5                 | 30  | 15  | 10  | 10  | 10  | 10  | 15  | 0   | 100       |
|                                  | Pollution control indoors | 2.5                 | 20  | 60  | 0   | 20  | 0   | 0   | 0   | 0   | 100       |
| Technical and economic benefits  | Technical index   | 6.0                 | 45  | 15  | 5   | 10  | 5   | 10  | 5   | 5   | 100       |
|                                  | Design conveniently | 1.5                 | 50  | 20  | 5   | 5   | 5   | 5   | 5   | 5   | 100       |
|                                  | Construct conveniently | 2.5                 | 40  | 30  | 5   | 5   | 5   | 5   | 5   | 5   | 100       |
|                                  | Save resources    | 4.0                 | 45  | 15  | 5   | 5   | 15  | 5   | 5   | 5   | 100       |
|                                  | Conducive to environmental protection interior and exterior environment | 2.0                 | 45  | 25  | 5   | 5   | 5   | 5   | 5   | 5   | 100       |
|                                  | technological innovation | 3.0                 | 40  | 45  | 15  | 0   | 0   | 0   | 0   | 0   | 100       |
|                                  | 1.0               | 30  | 20  | 10  | 5   | 10  | 10  | 5   | 10  | 0   | 100       |
| Function score of branch engineering Si | 452                | 247                | 326 | 576 | 617 | 896 | 327 | 251 |          |
|                                  | 9                 | 8                 | 326 | 576 | 617 | 896 | 327 | 251 |          |
|                                  | 0.45              | 0.25              | 0.03 | 0.06 | 0.06 | 0.09 | 0.03 | 0.03 | 10000   |
| Functional appraisal coefficient of branch engineering Fi(Fi = Σ Ai Bi / ΣΣ Ai Bi Ei) | 45.3               | 24.8              | 3.2  | 5.8  | 6.1  | 9.0  | 3.3  | 2.5  |          |
| Functional target cost Ci | 45.3 | 24.8 | 3.2 | 5.8 | 6.1 | 9.0 | 3.3 | 2.5 |          |

4.2.3. Collect similar technical parameters and LCC correction. Screening out 20 similar projects to statistical analysis and using 95% confidence interval, then get a proportion with branch engineering divide total cost. All above results as first revise date. Collecting construction cost and operation and maintenance cost of the 20 similar project. By determining the ratio of the two cost for the second revise
date. Statistic data showed in table 3.2. As is showed by table 3.2, Ai, Bi, Zj come from similar project, A, B and Z come from the project.

Table 4.2. Statistical analysis of cost proportion and calculations of adjustment coefficient both construction and operation and maintenance cost.

| Branch engineering | E1  | E2  | E3  | E4  | E5  | E6  | E7  | E8  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Sample size (n)    | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  |
| x(%)               | 55.709 | 26.368 | 1.097 | 3.820 | 2.148 | 4.361 | 2.511 | 3.989 |
| S (%)              | 5.049 | 5.586 | 0.345 | 1.288 | 0.419 | 0.851 | 0.781 | 0.949 |
| t_{α/2}(n – 1)     | 2.093 | 2.093 | 2.093 | 2.093 | 2.093 | 2.093 | 2.093 | 2.093 |
| Credit lower limit (%) | 53.346 | 23.757 | 0.936 | 3.217 | 1.952 | 3.963 | 2.145 | 3.544 |
| Credit upper limit (%) | 58.072 | 28.979 | 1.258 | 4.423 | 2.344 | 4.759 | 2.876 | 4.433 |

### 4.2.4. Synthesis correction to correction coefficient.

The next work is do a synthesis correction combined with table 4.2. This paper set K1=0.6, K2=0.4, K3 is from table 4.2.

Table 4.3. Comprehensive correction of functional target cost.

| Correction procedure | E1  | E2  | E3  | E4  | E5  | E6  | E7  | E8  |
|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Functional target cost C1 (%) | 45.3 | 24.8 | 3.2 | 5.8 | 6.1 | 9.0 | 3.3 | 2.5 |
| First correction coefficient K1 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Credit lower limit (%) | 53.346 | 23.757 | 0.936 | 3.217 | 1.952 | 3.963 | 2.145 | 3.544 |
| Credit upper limit (%) | 58.072 | 28.979 | 1.258 | 4.423 | 2.344 | 4.759 | 2.876 | 4.433 |
| First correction coefficient K2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| First revised cost Lower limit (%) | 48.518 | 24.383 | 2.294 | 4.767 | 4.441 | 6.985 | 2.838 | 2.918 |
| Upper limit (%) | 50.409 | 26.472 | 2.423 | 5.249 | 5.498 | 7.303 | 3.130 | 3.273 |
| Second correction coefficient K2 | 1.036 | 0.952 | 0.971 | 0.978 | 0.901 | 0.949 | 0.966 | 0.988 |
| Credit lower limit (%) | 50.265 | 23.213 | 2.227 | 4.662 | 4.001 | 6.629 | 2.741 | 2.883 |
| Credit upper limit (%) | 52.224 | 25.201 | 2.353 | 5.134 | 4.143 | 6.930 | 3.023 | 3.234 |

4.3. The comparison of before and after quota design optimization.

If the project according to the traditional quota design, the specific allocation ratio is shown in 4.4.

Table 4.4. Allocation ratio OF Traditional quota design.

| Branch engineering | E1  | E2  | E3  | E4  | E5  | E6  | E7  | E8  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Sample size(n)    | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  |
| Cost C (%)        | 55.709 | 26.368 | 1.097 | 3.820 | 2.148 | 4.361 | 2.511 | 3.989 |
| F (%)             | 45.3 | 24.8 | 3.2 | 5.8 | 6.1 | 9.0 | 3.3 | 2.5 |
| \(V=F/C\)         | 0.81 | 0.94 | 2.92 | 1.52 | 2.84 | 2.06 | 1.31 | 0.63 |

As is shown in table 4.4, the value of E1 and E6 far less than 1. This shows that those function took up a high proportion of the cost at present, but the function itself is not important. There may be excess function. Those function should be as a key object of study and looking for ways to reduce those costs.
On the contrary, we can see the value of $E_4$, $E_5$, $E_6$ and $E_7$ far more than 1. This indicates a serious mismatch in functionality and cost. There are many reasons for this result. Those function is more important, but the current cost is too low and may not fully implement the function. It should increase the cost to improve the degree of functional realization. This is a common cause. There will be many security risks in this situation, such as bring manufacture in a rough way, other quality accidents or security risks by low cost, and even lead to the project cannot complete the design requirements.

From above all, traditional quota design cannot control the economic benefits of the project well.

In order to more credible, this paper have done a questionnaire survey of residential function satisfaction and interview to related users. There is 91% users satisfied with the functions of the house. And only 41% surrounding district users satisfied with themselves function of house.

The optimized quota design, by contrast, in the case where the total limit value as well as the traditional method, fully utilized VE, which matches the cost and function, meanwhile, adjusts the allocation of design quota based on the whole life cycle cost. This reflects its advanced nature and scientific nature.

5. Conclusion
The real estate development projects have its own particularity. Reducing the cost can effectively stimulate investor’s enthusiasm for investment, and promote to form a healthy and sustainable development of the real estate industry. The optimized quota design take VE into reasonable distribution of design-limited. Meanwhile, giving a practical operational process. It not only can achieve a match on function and cost, but also focusing on effective control of life cycle cost. This improve the effectiveness of the quota design, meanwhile, it will conducive to the real estate market benign and sustainable development.

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