Research on owner functional structuring of EPC Project Based on QFD

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Abstract: Due to the advancement of the bidding time in the EPC mode, especially for the project owners who have tendered after the feasibility study or the design of the project can only propose the functional requirements of the project and cannot form a detailed bill of quantities, which is not conducive to the owners. The investment control has led to an increase in information asymmetry between the owner and the general contractor. To this end, this paper borrows the concept of “customer demand” in total quality management and the “QFD quality function development method” to identify the functional requirements of the owner and realize the transformation from the owner's functional requirements to the function list to the engineering quantity list. The owner can convert the qualitative functional requirements into a list of functions corresponding to the bill of quantities in the bidding stage, thereby solving the information asymmetry between the owner and the general contractor.

1. Introduction

Since the domestic engineering pricing measurement system is mainly based on the construction drawing, there is no corresponding pricing measurement rule for the project that adopts the EPC project general contracting. In practice, it is often difficult to apply the current engineering pricing system to the simulation. The list and the rate are lowered to bid for the tender. This method does not consider that the construction drawings under the general contract of the EPC project are designed by the general contractor, and the measurement of the construction drawings is completely unmatched with the general contracting of the project[1]. As a result, the functional requirements of the owner cannot be accurately transmitted to the general contractor, so that the functional requirements of the owner cannot be matched with the construction drawing, thereby further aggravating the information asymmetry between the owner and the general contractor.

Based on this, this paper borrows the concept of “customer demand” in total quality management and “QFD quality function development method” to identify the functional requirements of the owner, and realizes the transformation from the owner's functional requirements to the function list to the engineering quantity list. The owner can convert the qualitative functional requirements into the function list corresponding to the engineering quantity list in the bidding stage, thereby solving the information asymmetry between the owner and the general contractor, and improving the initial trust level of both parties, which is a trust type. The construction of the contract framework lays the foundation.
2. Literature review

QFD founder Akio Yoji believes that QFD translates consumer needs into technology, and then expands the design requirements to the quality of each functional part, component or service project. Mizuno believes that QFD is a systematic development of the function of forming quality. American scholar Cohen believes that QFD is a structured tool that clearly identifies the needs of customers. According to the above scholars' definition of QFD, it can be found that the research of QFD is essentially the same: (1) identify what is the real needs of customers; and (2) how to meet and meet these customer needs.

Due to the advancement of the bidding time in the EPC mode, the construction drawings under the general contracting of the EPC project were designed by the general contractor, and the functional requirements of the owner could not be accurately transmitted to the general contractor. In order to meet the needs of the owners, it is necessary to identify the functional requirements of the owners first, and then convert the qualitative functional requirements into a list of functions corresponding to the engineering quantity list. The research logic is the same as the research of QFD. Therefore, this paper uses the "QFD quality function development method" to convert the owner's functional requirements into a function list and then to the engineering quantity list based on the identified functional requirements of the owner, to solve the information asymmetry between the owner and the general contractor, and to satisfy Owner's needs.

3. Owner functional structured path

Through the above research, it can be found that the function list based on the component classification and the engineering quantity list based on the engineering work classification are different in nature and application scenarios, but the data on the bottom layer is related, that is, decomposed to a certain level, one The components will inevitably correspond to one type of work, which provides an opportunity for the combination of the two systems. In the United States, there are precedents for the Uniformat II system and the Masterformat system. Domestic scholars also have a study combining the Uniformat II system and the quota system. Based on this, this paper uses QFD quality function method to construct the conversion path from function list to engineering quantity list.

3.1 Conversion path from owner feature request to feature list

(1) Owner function request input

This section will identify the functional requirements of the owner as an input. Based on the list of functional requirements of the owner, the experts of the interview will score the importance of the list of requirements, as shown in Table 1.

| Serial number | Primary indicator | Secondary indicators | 3 points | 4 points | 5 points | Calculating the score |
|---------------|-------------------|----------------------|----------|----------|----------|----------------------|
| 1             | basic skills      | safety               |          |          |          |                      |
| 2             |                    | applicability        |          |          |          |                      |
| 3             |                    | Durability           |          |          |          |                      |
| 4             | Accessibility      | Aesthetic            |          |          |          |                      |
| 5             |                    | Intelligence         |          |          |          |                      |
| 6             |                    | Energy saving        |          |          |          |                      |
| 7             |                    | Other performance    |          |          |          |                      |

Since the selection of the functional requirements of the owner is based on a large amount of data collection and analysis by the staff, it is all in an important degree. Therefore, only three levels of 3 points, 4 points and 5 points are set (corresponding to important and important). And very important) Ask the experts to score and collect the specific importance scores by summarizing.

(2) "Owner Functional Requirements" to "Feature List"

The owner's functional requirements are identified as the original input in the model of the "owner's functional requirements-function list" converted by the EPC project owner's functional requirements.
The first layer of calculation process is as follows:

The first step: the owner's function requires the first layer corresponding to the transformation path, and the importance of the left-hand owner's functional requirements is based on the expert interview method. The “5” in the owner's functional demand weight (Ii) indicates the particularly important functional requirements of the owner; “4” indicates the more important functional requirements of the owner; “3” indicates the important functional requirements of the owner.

The second step: the relationship matrix. The research team invites relevant experts such as owners and general contractors who have rich experience in project general contracting projects, including senior experts such as Guangzhou Metro Group Construction Division, China Railway Guangzhou Engineering Bureau, Tianjin Polytechnic University, and consulting companies, and the function list correspondence matrix, the indicator of the BOM list expansion matrix is selected and rated. The relationship between the implementation element correspondence matrix and the quantization is in accordance with the 1-3 relationship degree level, with △ for 1 point, ○ for 2 points, and ● for 3 points, representing the calculation.

The third step: the function list importance Ti. The importance of the function list is calculated by the formula operation. The function weight of the i-th project owner is Ii, and the relationship between the i-th owner function requirement and the j-th function list is Sij, then the j-th function list importance Ti degree Then:

\[
T_j = \sum_{i=1}^{n} (I_i \times S_{ij}), j = 1,2,3, ..., mi
\]

The list of functions on the first floor includes: ① base A1; base A11, basement A12; ② outer closed works A2: above ground structure A21, building exterior facade A22, roof insulation waterproof A23; ③ building interior A3: interior wall A31, stairs A32, interior decoration A33; ④ supporting facilities A4: transportation system A41, piping system A42, power distribution system, lighting and power system (HVAC) A43, fire protection system A44, electrical system A54; ⑤ equipment and furniture A5: equipment A51, Furniture A52; ⑥ special building and building demolition A6: special building A61, building demolition A62; ⑦ general requirements A7. The conversion matrix of the first-level owner functional requirements and function list is shown in Table 2.

**Table 2. Level 1: Path transformation matrix from owner functional requirements to function list**

| Ty pe | Owner Functional Requirements | Detal ls Indicators | Importance of Owner Function | Base A1 | Outer Scal | Interior of the Building | Supporting Facilities | Equipmen t and Furniture | Special Building and Building Demolition | Total Requirements |
|-------|-------------------------------|---------------------|-----------------------------|--------|------------|-------------------------|----------------------|------------------------|---------------------------|-------------------|
|       |                               |                     |                             | A 1    | A 2        | A 3                     | A 4                  | A 5                    | A 6                        | A 7               |
| Basic Feature | | | | | | | | | | |
| Owner functional requirement | | | | | | | | | | |
| Basic A1 | | | | | | | | | | |
| Safety | 5 | ● | ● | ● | ● | ● | ● | | | |
| Applicability | | | | | | | | | | |
| Durability | 4 | ○ | ○ | ○ | ○ | ○ | ○ | ● | ● | ○ |
| Auxiliary Feature | | | | | | | | | | |
| Aestheticity | 3 | ○ | ○ | ○ | ● | ● | ● | ● | ● | ○ |
| Intelligence | | | | | | | | | | |
| Energy saving | 3 | ○ | ○ | ○ | ● | ● | ● | ● | ● | ○ |
| Other | | | | | | | | | | |
| Weight | 7 | 8 | 1 | 1 | 5 | 5 | 5 | 4 | 4 | 5 |
| Function list importance | | | | | | | | | | |
| | 2 | 2 | 3 | 4 | 2 | 2 | 1 | 1 | 1 | 1 |
| △ means 1 point, ○ means 2 points, ● means 3 points | | | | | | | | | | |
3.2 Conversion path from feature list to bill of quantities list

The second layer of the transformation of the functional requirements of the owner is to decompose and encode the engineering quantity list of the general contracting project after the preliminary design and to construct the conversion path from the function list to the engineering quantity list. The function list of the first layer output enters the second layer as the input end of the matrix, and is planned by the engineering quantity list matrix. The engineering quantity list formed by the conversion is based on the “General Construction Contractor Measurement Standard for Building Construction and Municipal Infrastructure Projects” (The draft for comments is selectively decomposed. The second layer of the conversion process of the owner’s functional requirements is as follows:

The first step is to use the engineering quantity list as an input index, and the quantitative index is summed according to the relationship calculated by the first layer, and the weight result is correspondingly filled into the left input end of the second layer project target expansion matrix.

(1) Relationship matrix. The engineering quantity list adopts the 1-3 relationship degree level, △ means 1 point, ○ means 2 points, ● means 3 points, uses Sij to represent calculation, indicator correlation and rating source are the same as the implementation element corresponding matrix, and is senior by engineering general contracting project. Experts conduct relationship analysis and grade selection.

(2) The project target importance Ti is calculated in the same way as the first layer. It is calculated by the formula. The i-th function list weight is Ii, and the relationship between the i-th function list and the j-th engineering quantity list is Sij, then the importance of the jth engineering quantity list is:

\[ T_j = \sum_{i=1}^{n} (I_i \times S_{ij}), j = 1, 2, 3, ..., mi \]  \hspace{1cm} (2)

The list of engineering quantities on the second floor is mainly derived from the first-level indicators of the “General Rules for the Pricing of Building Construction and Municipal Infrastructure Projects” (Draft for Comment). The decomposition indicators include:

- Earthwork B1; Ground Treatment and Slope Supporting project B2;
- basement protection project B3;
- pile foundation engineering B4;
- masonry engineering B5;
- reinforced concrete engineering B6;
- assembly engineering B7;
- steel structure engineering B8;
- wood structure engineering B9;
- Other components B10;
- roofing engineering B11;
- door and window engineering B12;
- exterior wall decoration engineering B13;
- interior decoration engineering B14;
- water supply and drainage engineering B15;
- fire engineering B16;
- ventilation and air conditioning engineering B17;
- electrical engineering B18;
- construction Intelligent engineering B19;
- elevator engineering B20;
- other installation engineering B21;
- general drawing engineering B22;
- measures project B23;
- external supporting project B24. The second level function list and the engineering quantity list conversion matrix are shown in Table 3.
### Table 3. Layer 2: Path Transformation Matrix from Function List to Bill of Quantities

| Function list indicator and importance | A1 | A2 | A3 | A4 | A5 | A6 | A7 |
|---------------------------------------|----|----|----|----|----|----|----|
| A1 1 1                                |    |    |    |    |    |    | 8  |
| A1 1 2                                |    | 6  |    |    |    |    |    |
| A2 1 0                                |    |    | 1  |    |    |    |    |
| A2 1 1                                |    | 7  |    |    |    |    |    |
| A2 1 2                                |    |    |    | 1  |    |    |    |
| A2 1 3                                |    |    | 2  |    |    |    |    |
| A2 1 4                                |    |    |    |    | 5  |    |    |
| A2 1 5                                |    | 5  |    |    |    |    |    |
| A3 1 7                                |    |    | 4  |    |    |    |    |
| A3 1 8                                |    |    | 3  |    |    |    |    |
| A3 2 1                                |    | 5  |    |    |    |    |    |
| A3 2 2                                |    | 5  |    |    |    |    |    |
| A3 2 3                                |    |    |    |    |    | 5  |    |
| A4 1 4                                |    |    |    |    | 5  |    |    |
| A4 1 5                                |    |    |    |    | 5  |    |    |
| A4 2 4                                |    | 4  |    |    |    |    | 4  |
| A4 2 5                                |    | 4  |    |    |    |    | 4  |
| A4 3 5                                |    | 4  |    |    |    |    | 4  |
| A4 4 6                                |    |    | 5  |    |    |    |    |
| A4 4 7                                |    |    | 5  |    |    |    |    |
| A4 5 5                                |    | 5  |    |    |    |    | 5  |
| A5 1 5                                |    |    |    |    | 5  |    |    |
| A5 2 5                                |    |    |    |    | 5  |    |    |
| A6 1 3                                |    |    |    |    |    |    | 3  |
| A6 1 4                                |    |    |    |    |    |    | 4  |
| A7                                    | 8  |    |    |    |    |    |    |
| **Bill of quantities Importance**     | 4  | 6  | 7  | 8  | 9  | 10 | 10 |
|                                       | 6  | 2  | 4  | 7  | 7  | 1  | 1  |
|                                       | 6  | 2  | 4  | 9  | 1  | 1  | 1  |
|                                       | 9  | 3  | 2  | 8  | 8  | 4  | 4  |
|                                       | 8  | 3  | 1  | 8  | 8  | 5  | 5  |
|                                       | 8  | 3  | 1  | 8  | 8  | 5  | 5  |
|                                       | 7  | 2  | 8  | 8  | 2  | 2  | 2  |
|                                       | 6  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 5  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 4  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 3  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 2  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 1  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 0  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 2  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 3  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 4  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 5  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 6  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 7  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 8  | 3  | 3  | 8  | 8  | 1  | 1  |
|                                       | 9  | 3  | 3  | 8  | 8  | 1  | 1  |

△ means 1 point, ○ means 2 points, ● means 3 points
According to the conversion path of “owner's functional requirements – function list – engineering quantity list”, this paper realizes the refined definition and overall planning of the project general contracting project, and forms a set to guide the implementation process, control project objectives and achieve. The structure of the functional owner's functional requirements is a key program for comprehensively and systematically planning the implementation of the project's general contracting project, and beneficially promotes the realization of the project objectives. According to the decomposition and coding of each task, according to the correlation between the indicators in Table 2 and Table 3, the implementation path of the owner's functional requirements is drawn, as shown in Figure 1.

![Figure 1. Owner function requires structured path](image)

### 4. Summary
This paper identifies the functional path of the owner's functional requirements: qualitative owner...
function requirements identification - function list construction (applicable to feasibility study or post-design bidding) - construction quantity list construction (applicable to preliminary design post-tender), and adopted The QFD quality function deployment realizes the multi-level transformation of the owner's functional requirements, so that the owner can convert the qualitative functional requirements into the function list corresponding to the engineering quantity list in the bidding stage, thereby solving the information asymmetry problem between the owner and the general contractor. Improve the initial level of trust between the parties.

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