Research on Cost Compilation of Terminal Project in the Design Stage

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Abstract: During the 13th Five Year plan, China's aviation industry continues to advance in the process of rapid development. This paper describes the characteristics of terminal building design from three aspects: building structure design, intelligent system design and process facility design. At the same time, this paper expounds that the engineering cost compilation of terminal project in the design stage should pay attention to the compilation scope, compilation method and cost index three parts. Finally, this paper takes a terminal project as an example, analyses its building structure cost, intelligent system cost and process facility cost, which more clearly reflects the engineering cost composition of terminal project in the design stage.

Keywords: terminal, design stage, engineering cost, cost index.

1 INTRODUCTION

As 14th Five Year Civil Aviation Development Plan shows, it is estimated that by 2025, the number of civil transport airports will reach over 270, with 17 million flights taking off and landing, a total transport turnover of 175 billion tonnage kilometres, 930 million passenger trips and 9.5 million tons of cargo [1]. Detailed data are shown in Table 1. The construction of civil aviation power in the 14th Five Year plan period will enter a new stage. The new development situation and new historical mission require the civil aviation to accelerate the transformation to high-quality development. Among them, terminal new construction, expansion construction, continued construction will gradually become the main melody of China's airport construction. Terminal as an important facility of civil aviation airport, due to its large size, various types of equipment, various forms of function, compared with other public buildings, the importance of terminal project cost is more important. The design stage has the greatest impact on the project cost and controls the maximum limit of the project cost [2], so in-depth study of terminal engineering cost, to optimize the terminal design scheme has very important practical significance.

Table1: Expected indicators of civil aviation development during the 14th Five-Year Plan Period

Serial number	Indicator		2020	2025
Guarantee capacity				
1	Number of civil airports (Pieces)		580	770
	Among	Civil transport airport (Pieces)	241	270

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	them：			
		Number of transport airport runways (strips)	265	305
2	Sorties of ensuring takeoff and landing (ten thousand sorties)		905	1700
3	Coverage of municipal administrative centre to transport airport in 60 minutes (%)		74.8	＞80
Industrial scale				
4	Total transport turnover (100 million tonnage kilometres)		799	1750
5	Passenger volume (hundreds of millions of people)		4.2	9.3
6	Cargo volume (ten thousand tons)		677	950
7	A share of China’s aviation enterprise accounting for China’s international cargo market (%)		33.8	≥40
8	General aviation flight volume (ten thousand hours)		281	450
	Among them: Cloud system drones volume (ten thousand hours)		183	250

2 TERMINAL BUILDING DESIGN FEATURES

2.1 Building Structure Design

As a complex building, the terminal is not only a transportation hub, but also the embodiment of a city culture, which is one of the city landmarks. Due to the outstanding nature of the terminal, its shape is often satisfactory and impressive. The design concept of the terminal is derived from the local natural landform, history and culture, and folk customs, from which designers extract design elements. Through simple volume, they recombine modern design techniques and building materials, so as to meet the modeling needs of complete functions and reasonable processes [3]. The terminal design is mainly reflected by the façade design, and the exterior decoration includes the roof system and the curtain wall system. Among them, the roof system of the terminal is mostly metal roof, using aluminium magnesium manganese alloy plate, steel plate, stainless steel plate, titanium zinc plate, etc. [8]. At the same time, the roof is equipped with light plate skylight. The selection of metal plate materials should reflect the modern sense on the one hand, and should have good weather resistance, pollution resistance and mildew resistance on the other hand. In addition, terminal curtain wall system, including frame glass curtain wall, point support glass curtain wall, all-glass curtain wall [9]. Most of the glass materials are toughened insulating glass, which has high permeability, can reflect the effect of light building form and space mobility, and meet the performance of thermal insulation, heat insulation, sound insulation, shading, wind pressure resistance, which is an important part of the visual beauty of the terminal. Supporting the shape design of the terminal is inseparable from the structural selection of the terminal. The structure of the terminal consists of the roof and the lower main structure. The roof mostly uses the space truss structure system, while the lower main structure is mostly steel frame or concrete frame structure system. Terminal structure design should pay attention to the column network layout, maximize the layout of the building plane.

2.2 Intelligent System Design

With the development of electronic technology, people put forward higher requirements for terminal service function, terminal should not only be the product of modern science, technology, culture and art highly developed, but also should be an important node and

component of modern information network technology. Terminal intelligent is an important symbol of the modernization of social development level, such as from perspective of safety, there are automatic fire alarm system and corresponding automatic spray and fire extinguishing system, automatic gas fire extinguishing system, automatic smoke control system, and anti-aircraft water cannon fire extinguishing system for large space. Due to the functional characteristics of the terminal, air transport to passenger luggage, cargo fire protection requirements are high, so the fire protection design of the terminal is particularly important [6]. In addition to reasonable fire partition, evacuation distance and the elimination of flammable building materials, fire alarm and fire extinguishing system plays a key role. Once the fire alarm sounds, the linkage systems starts at the same time, the air conditioning automatically closes, the powerful fan through the roof or window to emit air or smoke, the fire extinguishing system opens, the loss can be reduced to a small degree. From the passenger's point of view, there are dynamic flight display system, departure computer management system, clock system, broadcast system, TV monitoring system, sign light box system and touch screen automatic query system for high standard [7]. From the perspective of energy saving, there are automatic building control systems. (for lighting, air conditioning, ventilation, day lighting, etc.) From the safety of point of view, there is security monitoring system, emergency centre and so on. For office and communication automation needs, there is integrated wiring system and so on. In short, the intelligent system provides a modern management means for the terminal operation management. Its purpose is to realize the sharing of information resources, convenient centralized management to reduce institutional settings, improve service level and office efficiency, reduce costs and increase benefits.

2.3 Process Facility Design

Different terminal development stages, the selection of the terminal internal process facilities capacity is also different, with the change of time presents differentiation. Terminal process design mainly includes terminal boarding bridge, passenger baggage handling system, security inspection system, passenger guidance signage system, terminal catering, etc. [4]. Firstly, determine the preliminary terminal design process through the design scheme, and then design process facilities in each floor of the terminal. In addition, the demand of space location for terminal building structure should be proposed.

3 COST COMPILATION OF TERMINAL PROJECT

3.1 Cost Compilation Scope

Project overview is the basis of project cost analysis, is the description of the overall situation of the project, is conducive to reflect the technical and economic conditions related to the cost, which is not only the basis for decision maker to judge whether the cost is reasonable, but also the premise for user reference of similar project [5]. Terminal project overview according to its own characteristics can be subdivided into civil engineering, installation engineering and process facility. Among them, civil engineering includes ground treatment, construction engineering, decoration engineering. Installation engineering includes water supply and drainage engineering, fire protection engineering, ventilation and air conditioning engineering, gas engineering, power transformation and distribution engineering, electrical engineering,

weak current engineering. Process facility includes baggage system, security equipment, customs equipment, boarding bridge equipment, signage system, elevators and escalators, etc.

3.2 Cost Compilation Method

Perfect compilation basis is the premise of the compilation of the design budget estimate. First of all, collect and determine the compilation data of the budget estimate, mainly including the research and approval data, the scope and continent of the budget estimate, the project construction standard, the cost index of similar projects and the quota in the project location, and the related cost documents. Secondly, compile the construction cost, equipment procurement and installation cost, process equipment procurement and installation cost. Among them, the construction cost is generally compiled according to the drawings, the estimated quota of the project location, the cost document, the information price, while the estimate index method can be used by small structures. The price of local materials shall be compiled from the information price, and decorative materials shall be calculated according to the grade standard provided by the owner. The cost of equipment procurement and installation shall be estimated according to the list of equipment and materials provided by the designer and the brand provided by the owner by means of inquiry or reference to the price of equipment and materials database. Process equipment procurement and installation fees shall be calculated according to the process equipment table provided by the designer. Meanwhile, transportation and installation fees shall be considered according to the equipment conditions.

3.3 Cost Index Analysis

The cost index is the most important component of the project cost information, which directly reflects the economy of each function of the building. Terminal project cost includes construction, decoration and other civil engineering construction costs, water supply and drainage, fire protection, ventilation and air conditioning, refrigeration, power transformation and distribution, electric lighting, weak current and other equipment procurement and installation costs. Terminal cost index refers to the project cost apportioned to the terminal building area to reflect the cost level under the unit area [10]. The specific cost index is shown in Table 2. Classification, sorting and analysis of the completed terminal project cost basic data of the cost information with reference value, in the project decision-making stage, especially project initiation, feasibility and study stage, project data is not complete, drawings are not detailed, project cost index provides support and reference for project decision-making, project cost file formation and review.

Table2: Cost index of terminal project

Serial Number	Unit project	Construction cost		Equipment procurement cost		Equipment installation cost		Combined Price	
		Amount	Index	Amount	Index	Amount	Proportion	Amount	Index
		10000 Yuan	Yuan/m²	10000 Yuan	Yuan/m²	10000 Yuan	%	10000 Yuan	Yuan/m²
1	Civil engineering								
1.1	Ground treatment								
1.2	Constructio								

	n engineering								
1.3	Decoration engineering								
2	Equipment engineering								
2.1	Water supply and drainage engineering								
2.2	Fire engineering								
2.3	Ventilation and air conditionin g engineering								
2.4	Gas engineering								
3	Electric engineering								
3.1	Power transformati on and distribution engineering								
3.2	Electric lighting engineering								
3.3	Weak current engineering								
4	Passenger service facilities								
5	Terminal professional facilities and equipment								
5.1	Baggage system								
5.2	Security check system								
5.3	Customs equipment								
5.4	Boarding bridge equipment								
5.5	Signage system								
5.6	Elevator and escalator								
	Total								

4 INSTANCE ANALYSIS

4.1 Project Overview

An airport terminal is a 46673 square meters of three layers front terminal, the main body of the terminal is 3 floors, the first floor is the welcome hall, baggage room, equipment room, staff and cargo entrance and departure lounge. The second floor is the departure check-in hall, security hall, duty-free business street, etc. The third floor is the waiting area, food and beverage specialty area and VIP waiting area. After completion, the total capacity of this terminal can meet the current period (2025) annual passenger throughput of 25 million person-times, peak hourly passenger throughput of 1500 person-times, peak hourly take-off and landing sorties of 20.

4.2 Project Cost Index

The project cost is 689,671,700 yuan, construction cost is 369,734,300 yuan, equipment procurement cost is 228,898,100 yuan, equipment installation cost is 910,394,00 yuan. Detailed cost is shown in Table 3. As can be seen from Figure 1, civil engineering cost accounts for 54% of engineering cost at the highest level, followed by weak current engineering accounting for 17% of engineering cost, followed by process equipment accounting for 13%, and other specialties account for a small proportion of engineering cost.

Table3: Cost index of A project

Serial Number	Name of project and cost	Unit	Quantity	Unit price (Yuan)	Construction Cost (10000 yuan)	Equipment Procurement Cost (10000 yuan)	Equipment Installation Cost (10000 yuan)	Total (10000 yuan)	Proportion
1	Terminal	m^2	46673	14777	36973.43	22889.81	9103.94	68967.17	100%
1.1	Civil engineering	m^2	46673	7922	36973.43			36973.43	54%
(1)	Construction engineering	m^2	46673	4963	23165.41			23165.41	34%
(2)	Decoration engineering	m^2	46673	2958	13808.02			13808.02	20%
1.2	Water supply and drainage engineering	m^2	46673	174		299.73	512.94	812.66	1%
1.3	Fire engineering	m^2	46673	141		167.28	489.22	656.50	1%
1.4	Ventilation and air conditioning engineering	m^2	46673	584		798.20	1928.79	2726.99	4%
1.5	Refrigeration station	m^2	46673	125		378.91	202.56	581.47	1%
1.6	Fire-pump room	m^2	46673	35		90.08	71.96	162.05	0%

1.7	Power transformation and distribution engineering	m^2	46673	310		1215.99	230.57	1446.56	2%
1.8	Electric lighting engineering	m^2	46673	828		1205.77	2659.71	3865.48	6%
1.9	Weak current engineering	m^2	46673	2562		10082.93	1873.80	11956.73	17%
1.10	Process facility					8650.92	659.16	9310.08	13%
1.11	Seismic stabilizer bracket	m^2	46673	102			475.22	475.22	1%

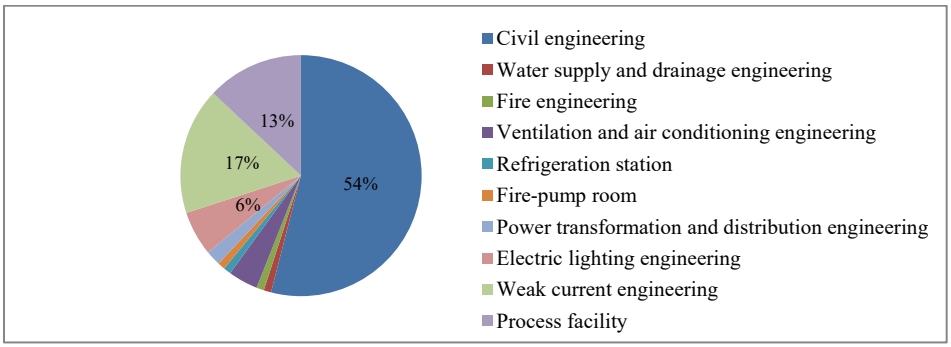

Figure1: Unit project cost ratio of A project

4.2.1 Cost of Building Structure

The roof of this project adopts space truss structure, the truss height is 2.5 meters, the truss spacing is 20 meters, and the lower main structure adopts steel frame structure system. Both the first and second floors are 6 meters tall, while the third floors are 12 meters tall. The roof is a metal roof, with aluminium magnesium manganese alloy waterproof plate, vertical locking structure and flexible waterproof layer. The curtain wall is a unit glass curtain wall with hidden frame. The consumption index involved in the cost of building structure of this project is shown in Table 4, which can reflect the consumption of main materials of this project.

Table4: Quantity consumption index of A project

Name	Quota man-	Steel	Concrete	Rebar	Glass	Block	Waterproof	Template
Unit	man-hour/m^2	kg/ m^2	m^3/ m^2	kg/ m^2	m^2/ m^2	m^3/	m^2/ m^2	m^2/ m^2
Index	5.80	135.00	0.39	42.00	0.25	0.30	0.70	1.25

The cost of building structure mainly includes the cost of steel structure, foundation, beam, plate, column, wall and other concrete structure, roof cost and curtain wall cost. Among them, the cost of steel structure accounts for a larger proportion of civil engineering cost, so the quantity and price of steel structure need to be calculated carefully. On the one hand, the index of single square meter steel structure should be at a reasonable level, and the content of steel structure can be slightly higher if the shape is unique. On the other hand, the price of steel structure includes production, installation, transportation, painting, coating and other costs. The price of main material should be adjusted according to the information price, and the overall price level is between 12000yuan/t and 16000yuan/t. Due to practices of waterproof and insulation are different, the overall price level of metal roof is between 900yuan/m^2 and 2000yuan/m^2. On account of the different thickness of toughened glass, the price of glass curtain wall (including keel) is at 1000yuan/m^2 to 2000yuan/m^2.

4.2.2 Cost of Intelligent System

The intelligent system of this project is based on the computer network system and ground information system, which realizes the mutual information networking of various electronic systems, including the computer network system, information integration system, wired communication system, flight information display system, electronic clock system, broadcasting system, building control system, video surveillance system, fire alarm and fire control system. Each system has a relatively small difference in the proportion of engineering costs, so corresponding system should be matched according to the specific situation of the project.

4.2.3 Cost of Process Facility

The design of process facility should be specified according to the capacity of process facilities. The process facilities of this project include passenger service facilities, elevators and escalators, baggage system, boarding bridge, security equipment, crossing management system and signage system. To calculate the cost of process facilities, first of all, the grade of facilities should be defined, and then the market inquiry should be carried out to obtain the procurement cost of the corresponding grade standard facilities. At the same time, transportation fees and installation fees should be calculated according to the specific situation of process facilities.

5 CONCLUSIONS

Terminal is a complex public building, as one of the city's business card, has a greater impact on the city. This paper analyses the terminal project design phase engineering cost, including construction costs, equipment procurement and installation costs, process equipment procurement and installation costs. The design phase should focus on the three costs that have a greater impact on the cost of the terminal, including the cost of the building structure, the cost of the intelligent system, the cost of the process and facilities. At the same time, cost index and project consumption index should be analysed according to the specific project, which is conducive to a more comprehensive, more overall analysis of the project cost.

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