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VALUE ENGINEERING ANALYSIS AND EVALUATION FOR THE SECOND BEIJING CAPITAL AIRPORT

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ABSTRACT

This paper adopts Value Engineering methodology to evaluate various schemes of The Second Beijing Capital Airport for maximizing value, instead of traditional minimum investment, shortest cycle time or highest quality respectively. Firstly, the Value Management procedure for Beijing Airport project is presented. Then, value chain and value list of this airport are proposed. Five kinds of schemes for The Second Beijing Capital Airport are discussed and the unfeasible ones are rejected. Finally, using fuzzy Quality Function Deployment (QFD), four potential new airport addresses are evaluated and the best value new airport address is recommended for decision-maker.

KEYWORDS

Value engineering, Value management, Beijing Capital Airport, Quality Function Deployment

I. INTRODUCTION

With the development of economy in China, the demand of the civil aviation is increased dramatically in Beijing district. The sharp contradiction will emerge between transportation demand and limited capacity of airport. Qin Youguo [1] predicted that existing facilities of the Beijing Capital Airport would not meet the demand after a few years (Table1).

Facing the contradiction, some new schemes for the programming of Beijing district Airport must be brought forward and determined by decision-makers. Traditionally, many people usually adopt Investment Theories [2] to compare various schemes. However, these theories do not include more stakeholder demands, such as performance for airport and passenger, availability and environment impact. So, this paper adopts Value Engineering (VE) and Value Management (VM) methods to evaluate all schemes for both customers' and other stakeholders' demands of Beijing Capital Airport.

Table 1
The Comparison of The Demand and Capacity of Beijing Capital Airport

Year	The amount of passenger per year (10,000)	The amount of carry per hour in peak		
		Sorties of taking off and landing of plane	Passenger throughput	The traffic flow from road to airport
2005	3300	70	12600	7900
2008	4200	90	16100	10300
2010	4900	100	18800	12100
2020	8000	160	30700	20600
Current capacity per hour		80	13200	9500

II. VALUE ENGINEERING ANALYSIS PROCEDURE FOR THE SECOND BEIJING INTERNATIONAL AIRPORT PROJECT

Value management has a systematic and creative procedure operating on the relevant aspects of the value process through the life of a project. The procedure of VE is a sequence of actions that lead to the achievement of value and can be divided into a number of major phases. There are many descriptions of the procedure of VE [3]-[6]. This paper presents the main VE Procedure for The 2nd Beijing International Airport Project and shows in Fig.1.

Phase 1: Define the scope of Value Engineering

It is the foundation of the VE study and should be initiated by the project manager. A preliminary

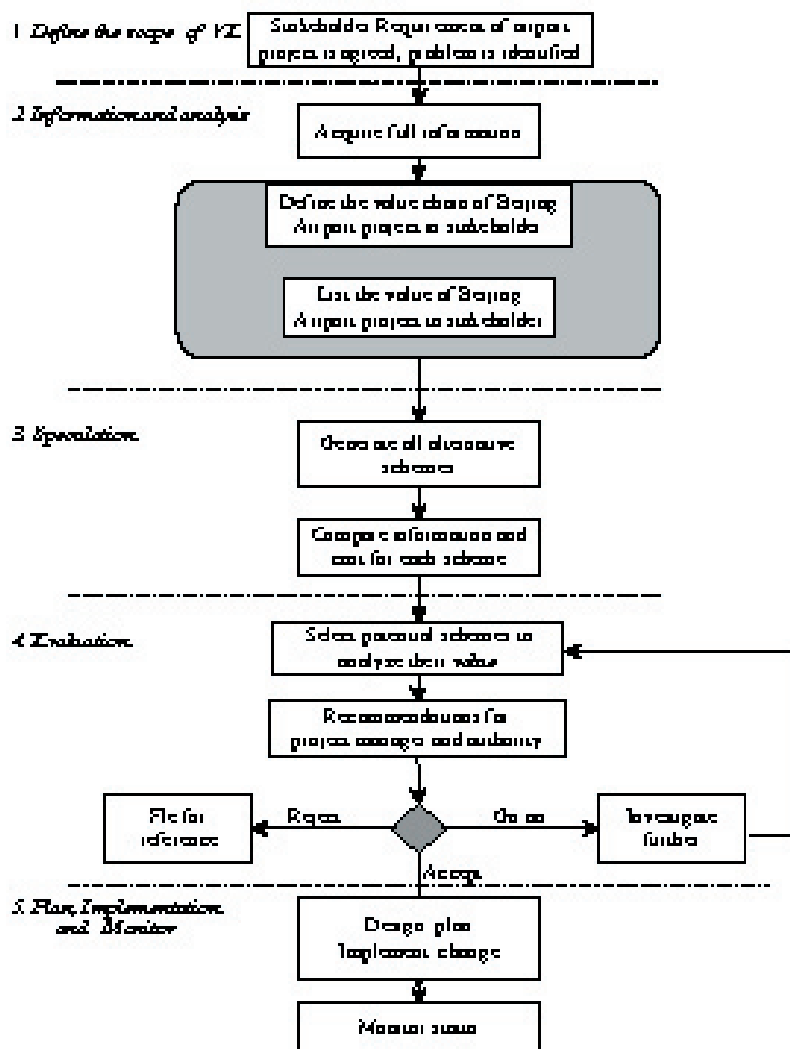


Figure 1. The main Value Management Procedure for the 2nd Beijing International Airport

nary assessment of the project should be made:

- The actual Stakeholder Requirements for project is agreed.
- The problem is identified and clearly defined.
- The study scope is defined.

In this phase, the identification of the Stakeholder Requirements is seen as a critical pre-study requirement for The 2nd Beijing International Airport VE study in that it is a specific statement of the functional requirements.

According to “The Medium-term and Long-term Development Program for Beijing District Airport”, the final objective of the 2nd Beijing International Airport is a large-scale international airport, which has four runways and a capability of 80 million passengers per year in 2020.

Phase 2: Information and analysis

During this phase the majority of the information that is needed to conduct the study should be collected, collated, validated and compiled into an information data pack.

Also, the value of the 2nd Beijing International Airport Project is defined and listed in this phase.

Phase 3: Speculation

The speculation phase is the most important phase of VE, for it is at this point that we propose the alternatives. At this point the whole team members should be involved in discussion, break the mould of the project and generate fresh ideas. In this paper, four kinds of alternative schemes of The 2nd Beijing International Airport Project are discussed.

Phase 4: Evaluation

The final selection of schemes is put forward for a full evaluation in the phase. An alternative proposal is prepared by the value engineer and will be presented to the project manager.

Phase 1-4 above constitute the main process of value analysis.

Phase 5: Plan, Implementation and Monitor

The value engineer must generate a plan of action that will cover all the tasks necessary for the implement phase. The plan should be showed that how, what, where and who will do this relative task. The implementation of VE should be monitored.

The value of The 2nd Beijing International Airport Project to stakeholders and evaluation of various schemes are discussed mainly in the following sectors.

III. DEFINE THE VALUE OF THE SECOND BEIJING INTERNATIONAL AIRPORT PROJECT TO STAKEHOLDERS

Value of project should be defined by stakeholders. According to PMBOK [6], project stakeholders are individuals and organizations that are actively involved in the project, or whose interests

may be positively or negatively affected as a result of project execution or project completion; they may also exert influence over the project and its results. Key stakeholders on airport project include: sponsors (government), customers (passengers), and performing organization (airport authority).

On the other hand, value of project is also determined by both deliverables and work process attributes. Activity and final deliverables all affect value of project. It is increased by improved performance and decreased by greater cost and lead time. Similarly, interim activities and deliverables also affect value, both in terms of benefits and costs. The Figure 2 depicts the influence of both the airport project construct process and deliverable (airport facilities and services) on value to both stakeholder and customer. The eight questions that list within the figure reveal these influences on performance, affordability, availability and environment impact.

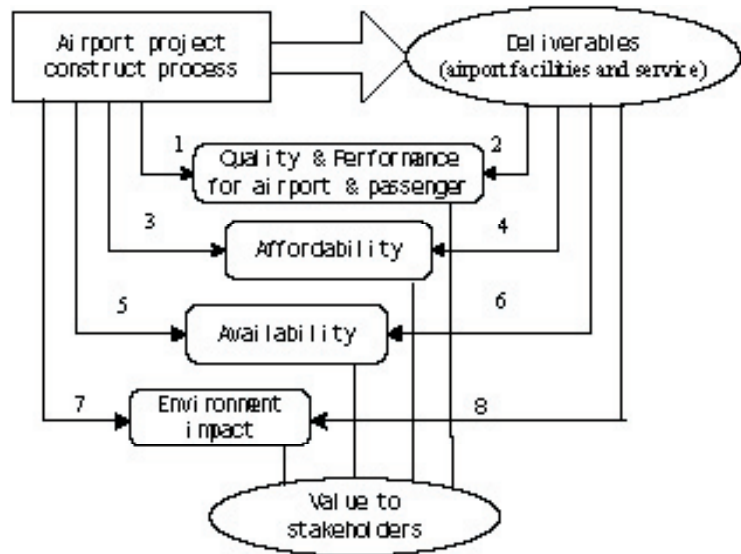


Figure 2. Value Chain of the 2nd Beijing International Airport Project

1. Does the airport project construct process include all the right activities producing all the right deliverables to ensure that the deliverables of project meet customers' needs?
2. Does the deliverables of project meet stakeholders' and customers' needs?
3. Does the work process have low cost (and low cost risk)?
4. Have the deliverables of project been designed to have low life cycle costs?
5. Does the work process have fast cycle time (and low time risk)?
6. Have the deliverables of project been

- Performance for airport and passenger*
- Airspace condition*
- Headroom condition*
- Geologic condition*
- Weather and atmosphere condition*
- Distance from airport to downtown*
- Affordability*
- Investment of airport construction*
- Cost of housebreaking*
- Investment of ground traffic*
- Availability*
- Construction cycle*
- Local material supply*
- Water resource*
- Public facility*
- Environment impact*
- Noise pollution*
- Development correspond with city program*
- Utilize less fertile land*

Figure 3. Value List of The 2nd Beijing International Airport Project

designed to minimize lead time?

7. Does the work process have low environment impact?

8. Has the deliverables of project been designed to minimize environment impact?

We can get demands of customers and stakeholders for the 2nd Beijing International Airport [8] which is shown in Figure 3.

Performance for airport and passenger, especially airspace and headroom condition, are essential factors and precondition for any airport scheme. Only when they are suitable for Beijing Airport, we can continue to evaluate it.

IV. VALUE ANALYSIS AND EVALUATION VARIOUS SCHEMES

A. Primary Value Analyses of various schemes about The 2nd Beijing International Airport

At present, four potential schemes have been brought forward for the program of The 2nd Beijing International Airport. Various alternative schemes are analyzed using value engineering as followings.

(1) Reconstruction of the current Beijing Capital Airport

Reconstruction of the current Beijing Capital Airport is one of the most effective means to alleviate its pressure. In fact, reconstruction and extension project has never been stopped since the Capital Airport was established.

The purpose to reconstruction Beijing Capital Airport lies in fully utilizing the existing resources, breaking through “bottleneck” and creating scale benefit. This scheme is less trouble for airlines to assign the flight among different airports.

However, some factors which restrict current Beijing Capital Airport to meet the demands of aviation transportation in 2020 are as followings:

a. Traffic control in the air

According to Beijing Daily in September 4, 2000, the number of plane taking off and landing brought 600 sorties on the same day and a large number of flights were delayed. It was not caused by the capacity of facilities of the airport, but due to the traffic control in the air. This exposed the problem of air traffic control in Beijing Capital Airport.

b. Restriction on land

The development space is very limited in the surrounding area of the Beijing Capital Airport at present.

c. Noise pollution

At present, there are 18 villages in Beijing Capital Airport District where the noise grade felt in succession is above 70 decibels. It is expected that the number of these villages will reach to 40-43 in 2005. But it is not suitable for resident if the noise above the 75 decibels according to the international standard.

d. Insufficient water resource

The source of water may be insufficient for the further development of the airport. Because of ultra exploiting field of groundwater, the source of water may hardly be solved for a long-time.

e. The city traffic suppressing

Because the Capital Airport is the only formal civil airport in Beijing at present, nearly all the passenger's traffic flow from downtown point to there. Thus the Urban Road System hardly endures the enormous unbalanced pressure of the whole city traffic.

To meet the demand for the capacity of land traffic system of the Capital Airport future development, new traffic way from downtown to airport must be introduced.

(2) The Union of Beijing Capital Airport and Tianjin Strand Airport

Tianjin Strand Airport covers an area of 7 million square meters, which has airport waiting room of 20,000 square meters and freight transportation warehouses of 60,000 square meters. It has been one of the most advanced and the largest center for aviation goods collecting and distributing when it was built up. But at present, its capability is not utilized sufficiently.

In order to fully utilize the resources of Tianjin Strand Airport, they can be united. The distance between Beijing Capital Airport and Tianjin Strand Airport is 126 km and it will take us one and a half hours between the two airports. However, passenger trip mode is decided freely and mainly depending on two factors: the level of airport service and the easy-reaching coefficient for the two airports.

The index of airport service level involves management ability of airport authorities, service facility, amount of airline and so on. In terms of the easy-reaching coefficient for the two airports, in order to determine its value, we have to consider the means of transportation, time consuming, expenditure of expenses, etc. All these factors reflect the facility for passenger to reach airport. Because the number of airline in Tianjin Strand Airport is limited and long distance between two airports, it will create inconvenience for passenger.

Hence, Tianjin Strand Airport is not fit for the 2nd Beijing International Airport. The development program of Tianjin Strand Airport should consider the aviation marketing demands of Tianjin City and its surrounding town..

(3) Preparatory addresses in Beijing

Preparatory addresses are Panggezhuang and Zhangjiawan respectively, which locate in the south of Beijing. Their advantages are the appropriate traffic distance to Beijing, smooth

hypsography and convenient public facilities. No matter how the headroom, weather and atmosphere and geologic condition, both addresses are fit for the requirements of airports construction. But mainly due to the forbidden zone in Beijing for Panggezhuang and airspace restrict for Zhangjiawan, it is not suitable for both addresses to build a large civil airport.

(4) Reconstruction existing military airport in Beijing for the second civil airport

There are 5 military airports around the Beijing urban area. But most of them are near mountains. Due to the forbidden zone in Beijing and airspace restrict, it is not suitable for these existing military airport to build a large civil airport.

All above schemes are not fit for the 2nd Beijing International Airport because of their air-space condition and ground traffic. So, new address should be recommended.

(5) Establish a new airport for the 2nd Beijing International Airport

The voice of building a new second civil airport in Beijing has lasted for a long time. In fact, the planning place for the second airport has been prepared since 1993 in the program of the Beijing City. Comparing to the reconstruction, it is can offer more imagination space for the policymaker that building a new Second civil airport. Some experts suggested the Second Beijing International Airport should be located in Langfang city of Hebei Province.

Four potential airport addresses are recommended as the 2nd Beijing International Airport (Table 2). In the following, we use fuzzy logic to evaluate these addresses.

B. Value Evaluate to find the Best Airport Addresses for The 2nd Beijing International Airport

Firstly, relation matrix of Quality Function Deployment (QFD) is set up between stakeholder demands and potential airport addresses (Table 2).

The left column in the matrix is the Factors Vectors U:

$$U = \{u_1, u_2, u_3, \dots, u_m\} \tag{1}$$

Various Potential Airport Addresses are list in the top row. They compose Schemes Vectors V:

$$V = \{v_1, v_2, \dots, v_n\} \tag{2}$$

Firstly, the weight of every factor is calculated in Factors Vectors U. Expert judge method is adopted to obtain the importance comparison matrix between each demand. Then summing method is utilized to obtain relative weight vectors \tilde{W} of all demands. Here, \tilde{W}_0 describes the relative weights of the four top-level indexes which are performance, affordability, availability and environment impact. $\tilde{W}_1, \tilde{W}_2, \tilde{W}_3$ and \tilde{W}_4 describe respectively of the second-level index.

$$\tilde{W}_0 = \begin{bmatrix} 0.445 \\ 0.283 \\ 0.165 \\ 0.107 \end{bmatrix} \quad \tilde{W}_1 = \begin{bmatrix} 0.341 \\ 0.135 \\ 0.077 \\ 0.072 \\ 0.375 \end{bmatrix} \quad \tilde{W}_2 = \begin{bmatrix} 0.581 \\ 0.110 \\ 0.309 \end{bmatrix} \quad \tilde{W}_3 = \begin{bmatrix} 0.282 \\ 0.128 \\ 0.350 \\ 0.240 \end{bmatrix} \quad \tilde{W}_4 = \begin{bmatrix} 0.266 \\ 0.195 \\ 0.539 \end{bmatrix}$$

Multiplying weights of the top-level stakeholder demands by weights of the second-level stakeholder demands, weights of all customer demands is obtained and list them in Table 2.

Table 2 The Relation Matrix Between Stakeholder Demands and Potential Airport Addresses Potential new airport addresses					
Stakeholder Demands	Customer importance (weight)	Address A	Address B	Address C	Address D
Performance for airport and passengers	Airspace condition	0.152	□	○	○
	Headroom condition	0.060	□	●	●
	Geologic condition	0.034	□	□	□
	Weather and atmosphere condition	0.032	□	□	□
	Distance from main service public to airport	0.167	●	□	□
Affordability	Investment of airport construction (Billion ¥)	0.164	●	●	□
	Cost of housebreaking (Million ¥)	0.031	□	□	□
	Investment of traffic from city to airport	0.087	●	□	□
Availability	Construction cycle	0.047	●	□	□
	Sufficient local material supply	0.021	●	●	●
	Convenient public facility	0.058	□	□	□
	Sufficient water resource	0.040	●	□	□
Environment impact	Noise pollution to surrounding town	0.028	□	□	□
	Utilize less fertile land	0.021	□	●	●
	Development correspond with city program	0.058	●	□	□
Primitive value		0.840	0.708	0.675	0.547
Relative value		154	129	123	100

Identifying the intensity between factors and schemes is an importance step for QFD. Professor Akao Yoji [9] indicated that it is the most difficult problem in the process of building House of

Quality. They are usually set up according to experience, intuition and determination. How to scale these subjective and fuzzy decision is the key for utilization QFD. This paper adopts fuzzy logic to measure the contribution degree that airport addresses to corresponding stakeholder demands and evaluate them by five ranks. They are denoted by following symbols.

\triangle = very weak, \circ = weak, \odot = medium, \otimes = strong, \bullet = very strong.

According to statistic results of psychology [10], the fuzzy membership of each rank is equal to:

$$\triangle = 0.08, \circ = 0.28, \odot = 0.54, \otimes = 0.77, \bullet = 0.91$$

So, the correlation matrix between customer demands and potential new airport addresses can be denoted as following:

$$\tilde{R} = \begin{bmatrix} r_1 & r_2 & \dots & r_{1n} \\ r_2 & r_2 & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & \dots & r_m \end{bmatrix} \quad (3)$$

Here, r_{ij} denotes the degree of the contribution that scheme j to factor i . Hence, the primitive value of each new airport address that it satisfies all stakeholder demands can be calculated using the formula (4).

$$\tilde{B} = \tilde{W} \cdot \tilde{R} = \sum_{i=1}^m w_i \cdot r_j = (b_1, b_2, \dots, b_n) \quad (4)$$

Higher score shows that higher degree that the scheme satisfies all stakeholder demands. Finally, setting the lowest value of address as 100, we can get the relative value of other addresses.

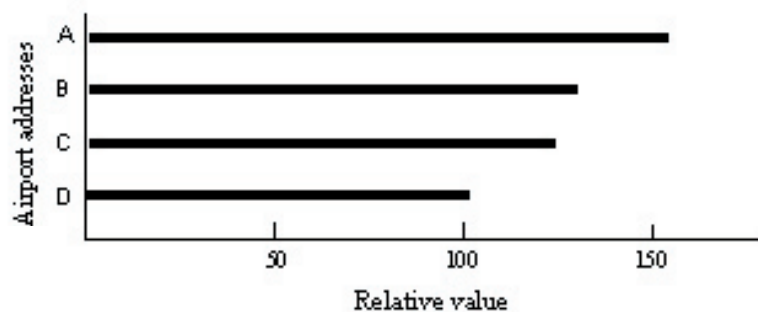


Fig.4 relative value of various airport addresses

From Tab.2 and Fig.4, we can see that address A has relative higher score than other addresses and it is the best new airport address for The Second Beijing Capital Airport, because it has better airspace condition, near distance from Beijing to the airport, sufficient water resource and correspond with surrounding city programs.

V. CONCLUSION

VE/VM is distinguished from all other cost reduction/cost avoidance techniques in that its initial aim is to determine that the project, component or part is both necessary and meets the Functional User Requirements. This paper adopts Value Engineering methodology to evaluate five possible schemes of The Second Beijing Capital Airport for maximum value and reject unfeasible schemes. Four potential new airport addresses are evaluated using fuzzy logic and the best value new airport address is recommended for decision-maker.

REFERENCES

- [1] Qin youguo, Wang Zhaobin. The Study on the Development of Civil Airport in Beijing [J]. Beijing City Planning & Construction Review, 2001,4: 27-30
- [2] Rigas Doganis, The Airport Business, Publisher: London; New York: Routledge, ISBN: 0415078776 0415081173, 1992
- [3] John W. Value methodology standard [EB/OL]. <http://www.value-eng.com>
- [4] Thiry M, Value management practice [M]. NC: Project Management Institute, 1997.
- [5] Alan W. Value engineering: part 1 [J]. Engineering Management Journal, 1993,27(8): 171-175.
- [6] Alan W. Value engineering: part 2 [J]. Engineering Management Journal, 1993,29(10): 231-235.
- [7] A Guide for Project management Body of Knowledge. <http://www.pmi.org>
- [8] Criterion for civil aviation transportation airport address [M], Beijing: General administration of China civil aviation, 1997.
- [9] Akao, Yoji.. QFD, Integrating Customer Requirements into Product Design. Productivity Press.U.S.A., 1990
- [10] Ma Mouchao. Fuzzy statistic analysis on words and expressions evaluation [J], Psychology transaction, 1990,19(5): 14-17.

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