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Value Engineering for Flat Bottom Steep Projects: Cost-Control Objects Selection

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Abstract

Value engineering is an effective method to cut down costs and increase economic benefits. It is said that 80% of the manufacturing cost is decided by the design phase, so the high manufacturing costs of the flat bottom steep will undoubtedly increase the costs of malting and reduce the profitability of the enterprise, showing that there are lots of parts can be optimized in the design phase. Therefore, it is necessary to deploy value engineering theory to the product design phase in order to select the objects of innovation and to control the costs of flat bottom steep effectively.

Key words: Value engineering; Flat bottom steep; Customer demands analysis; Cost-Control objects

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INTRODUCTION

Malt is the main raw material for brewing beer, which is processed by barley. Malting is the professional germination and drying process for barley under manual monitoring. The malting process and the related equipment are shown in Table1.

Table1
Malting Process and Equipment

Process	Equipment
Pretreatment for barley	Rougher & Grader
Steeping	Steeping tank
Germination	Germination boxes
Drying	Drying oven
De-rooting	Root peeler
Storage	Warehouse

Steeping is the crucial process to increase the water content of barley so as to reach the germination requirements (42%−45%), whose main purposes are improving water content, removing the dust, impurities, microbes and wheat husk, leaching harmful substances of epidermis (such as phenols).

As flat bottom steep is the new kind steeping apparatus, its production capacity, ventilation, stirring and cleaning effects are all better the traditional cone bottom steep. However, flat bottom steep is approximately 20%~30% more water consumption than the cone one because of the larger water coverage area of barley. In addition, more attachments and difficult machining process and crafts cause the higher manufacturing costs and operating consumption of flat bottom steep which would squeeze the profit margins. Therefore, it's necessary to optimize the design in order to control the costs. The value engineering theory is undoubtedly the best way for this task.

1. RESEARCH STATUS OF VALUE ENGINEERING

Value engineering, also known as value analysis, is a new management technique and an effective method to improve and guarantee product functionality, to decrease costs, and to enhance economic efficiency. This technology, originated in the United States, was put forward and consolidated by Lawrence D. Miles inspired by "asbestos incident" in 1947. It is a scientific management technique whose occurrence and development is accompanied by modernization of production.

So far, the theory of value engineering has been widely employed around the world. During the information and technology wave, scholars from all circles deepened the research and achievements emerged constantly. The applications of computers and related softwares redesigned the value engineering steps, institutionalized and streamlined the management tools. Besides, the theoretical system has also been enriched and perfected in the practical application.

In the aspect of theory, Stuart (1994) proposed the concept of intelligent value management. Rwelamila (1994) put forward hybrid value engineering (HVE), a secondary tool of value engineering, and tried applicatory it to the construction. Kawakami, Katai, Konishi, and Iwai (1996) proposed and applied a knowledge acquisition method for conceptual design based on value engineering and axiomatic design theory. Seunghoon, Changtaek, and Taehoon (2009) found that VE team always ignored some creative suggestions while applying value engineering, then they put forward a creative-awakening tool, RETIEVE (Remembering Tool for Reusing the Ideas Evolved in Value Engineering) and applied it to the construction industry. Boo, Syadaruddin, Hyung, and Young (2009) applied process simulation technology to value engineering model and proposed an advanced five-phase VE model (information phase, speculation/creative phase, evaluation/analytical phase, development/recommendation phase, report and implementation phase) to improve analysis.

In the aspect of practice, Zhang and Huang (2007) applied value engineering to optimization of highway tunnel construction. Han, Shao, and Zhang (2011) applied value engineering to diesel engine to optimize the assembly crafts and to realize low fuel consumption. Zhang, Zhang, and Dong (2011) employed value engineering to real estate projects and proposed the general function indicator system of real estate projects. All of the practices contributed significant cost savings to the projects, proving the application of value engineering would produce real benefits for the enterprises.

2. CUSTOMER DEMANDS ANALYSIS OF FLAT BOTTOM STEEP

2.1 Importance of Customer Demands Analysis

The existence of any product is because of it can meet customers' certain demands or requirements. Customer demands, as the only bridge between customer and market, play a decisive role not only in design and production of products, but also in win the market share. The incomplete, misunderstanding and vague definition of customer demands will mislead the comprehending of product in subsequent product life cycle phases, especially in design phase, causing the deviations between customer requirements and products, and losing the entire market eventually. Therefore, attaching importance to customer demands is particularly significant for early product design phase.

Previous applications of value engineering have always overlooked the essentiality of customer demands for products or service, resulting in the failure of some value engineering activities. For the above reasons, the value engineering team should emphasize on transferring the specific customer demands into the information understood by designers, manufacturers and managers at all levels when carrying out value engineering tasks, in order to ensure the final design will satisfy the customer.

2.2 Customer Demands Analysis

Understanding the significance of customer demands, the corporate convened the experts team (product engineers, marketing specialists, customer service supervisors, etc.), and determined the demands analysis items of flat bottom steep, as well as the necessary elements of each item by brainstorming, according to the functions and standards of flat bottom steep, combined with the principles and methods of demands analysis. After that, the team calculated the index of all the demands elements of flat bottom steep through analytic hierarchy process (AHP). The customer demands indicator system or weights system and the calculations are shown in Table 2.

Table2
Weight Criterion Layer of Customer Demands of Flat Bottom Steep

Criterion	Practicability-ability B_1	Operation B_2	Economy B_3	Safety & Reliability B_4	Mechanism -capability B_5	Weight of each indicator to the overall goals
	0.4752	0.0739	0.0713	0.1335	0.2461	
Clean B_{11}	0.0548					0.0260
Ventilation B_{12}	0.5744					0.2730
Stirring B_{13}	0.2672					0.1270
TemperatureB_{14}	0.1036					0.0492
Clear panel B_{21}		0.4088				0.0302
Bright lights B_{22}		0.1858				0.0137
Button layout B_{23}		0.1072				0.0079
Clear screen B_{24}		0.2981				0.0220
Cost-effective B_{31}			0.0645			0.0046

To be continued

Continued

Criterion	Practicability-ability B_1	Operation B_2	Economy B_3	Safety & Reliability B_4	Mechanism -capability B_5	Weight of each indicator to the overall goals
	0.4752	0.0739	0.0713	0.1335	0.2461	
Maintenance cost B_{32}			0.0895			0.0064
Water consumption B_{33}			0.4222			0.0301
Material saving B_{34}			0.2987			0.0213
Service life B_{35}			0.1250			0.0089
Flexibility B_{41}				0.5390		0.0720
Work security B_{42}				0.2972		0.0397
Hygienic standards B_{43}				0.1638		0.0219
Rigidity B_{51}					0.0964	0.0237
Loading capacity B_{52}					0.2842	0.0699
Driving stability B_{53}					0.6194	0.1525

3. FUNCTIONAL ANALYSIS OF FLAT BOTTOM STEEP

Functional analysis mainly covers three steps: functional definition, functional classification and functional finishing. Any kind of product consists of many components which all together constitute the structural system of the product. Each component of product has different functions, interacting with each other and forming the functional system of product. Although the structural system and the functional system jointly meet the customer demands, they can't be confused. The structural system is the physical entities of the product, while the functional system reflects the ultimate demands of customers which can not be shown directly by eyes. Value engineering tasks are carried out from the function perspective and pay attention to the study of functions so as to optimize the product design and cut down costs.

Table 3 witnesses the physical structure of flat bottom steep and the specific functions shouldered by each component. Considering the complexity of the equipment and the amount of the components, the team only sorts the key components, instead of listing all the parts.

Table 3
Physical Structure of Flat Bottom Steep and Functions of Each Component

Fist lay of physical structure	Second layer of physical structure	Functions
Supporting structure	Base support	Loading and supporting
Electrical control structure	Switch cabinets and control panels	Start/stop the equipment Design and transmitting operational signals
	Emergency brake switch	Brake on or off the equipment in case of emergency
	Liquid level measuring device	Detecting the indicators of steeping water
	PT100 temperature sensor	Transmitting parameter signals of temperature
	CO_2 on-line monitoring system	Detecting the amount of CO_2
Feeding and discharging material structure	Feeding material device	Feeding barley into the flat bottom steep
	Discharging material device	Discharging the barley from the equipment into the germination boxes
Steeping structure	Sieve plates device	Blasting air and cleaning the plates
	Overflow device	Isolating and collecting impurities
	Plenum device	Ventilating and supplying O_2
	CO_2 suction device	Exhausting CO_2
Stirring structure	Loading and unloading device With rotating manipulators	Stirring the barely evenly And cleaning the inner walls of the equipment
Seal and security structure	Airtight doors	Isolating from the air
	Watertight doors	Sealing the steeping water
	Railings, pedals and grilles	Ensuring the safety of climbing
	Cover and casing	Sealing the entire equipment
Temperature control structure	Cooling system	Cooling the equipment and preventing overheating of the steeping water
	Heating system	Heating and providing the required steeping temperature

4. DETERMINATION OF FUNCTION COEFFICIENTS

4.1 Necessity of Transferring the Customer Demands to Product Functions

Customer demands are indispensable factor for the success of product design, while product functions are the carriers of customer demands, Therefore, integrating customer demands into product design is in fact to transfer customer demands into particular product function, and satisfying the multilayer needs of customers through the combination and adjustment of different functions. Only after understanding the customer demands comprehensibility, will the managers accurately select the product with competitive advantage based on the enterprise's economic strength, technological superiority, profitability and so on. Hence, the purpose of drawing the demand-function incidence matrix is to pass customer demands on product functions.

4.2 Transformation From Customer Demands Weights to Function Coefficients of Components

Due to satisfaction of customer demands reflected in realization of product functions, demand-function incidence matrix should be drew to pass the requirements onto the functions. After that appropriate relationship between functions and demands would be found.

Product components are the carriers and solid foundation of product functions. The team built function-component incidence matrix to transfer importance of functions to function coefficients of particular component. Since the electrical control structure are out-scouring parts, the team saw them as an independent system. Besides, the team combine the item "railings, pedals, grilles, airtight doors and watertight doors" into "doors, handrails, etc." in order to facilitate calculation. Finally, each function coefficient of component was calculated through the transfer of demand-function-component .

5. DETERMINATION OF VALUE COEFFICIENTS AND SELECTION OF COST-CONTROL OBJECTS

5.1 Determination of Value Coefficients

Cost coefficients, also known as cost index, represent how many portion of each component cost account for the total costs. The formula is as follow: $CI_i = C_i / \sum C_i$ (i=1~13)

Where, CI_i is the cost coefficients of i component, and C_i is the cost of i component.

After the calculation of function coefficients and cost coefficients, value coefficients of each component could be achieved based on the formula: $V=F/C$ (V: value coefficients; F: function coefficients; C: cost coefficients). The results are shown in Table 4.

Table 4
Value Analysis of Flat Bottom Steep

Components	Cost analysis			Function analysis		Value analysis	
	Cost (million)	Cost coefficients(%)	Rank	Function coefficients(%)	Rank	value coefficients	Rank
Sieve plates device	25.941	35.91	1	17.33	3	0.48	12
Loading and unloading device	11.68	16.17	2	13.55	4	0.84	9
Electrical control	11.2	15.51	3	19.49	1	1.26	7
Plenum device	5.707	7.90	4	8.11	5	1.03	8
CO_2 suction device	4.178	5.78	5	17.88	2	3.09	2
Feeding device	3.182	4.41	6	2.52	9	0.57	11
Cover and casing	3.18	4.40	7	1.69	10	0.38	13
Base support	3.023	4.19	8	4.90	7	0.83	10
Overflow device	1.561	2.16	9	7.79	6	3.61	1
Discharging device	1.512	2.09	10	2.48	8	1.19	5
Heating system	1.01	1.14	11	1.35	12	1.18	6
doors,handrails,etc.	0.569	0.79	12	1.66	11	2.10	3
Cooling system	0.489	0.68	13	1.25	13	1.83	4
Total	72.232	100		100			

5.2 Selection of Cost-Control Objects

The team applied the method of the most reasonable region proposed by Mr. Tanaka, which used the value coefficients to determine cost-control objects accurately. According to the theory, the team established a XY Cartesian coordinate system, shown in Figure 1, regarding cost coefficients and function coefficients as the X axis and the Y axis respectively, and drew a straight line with 45° angle between itself and the X axis which represented V=1. The most reasonable region was formed by the two curves $Y_1=(X^2-2S)^{-2}$ and $Y_2=(X^2+2S)^{-2}$, X was cost coefficients, Y was function coefficients, S was a given constant, and $S=5000/n^2$. The spots fell outside the region were considered as the selected objects need to be improved to reduce the cost of the flat bottom steep.

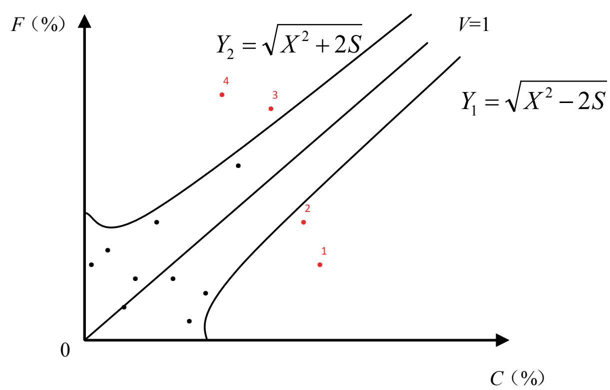

Figure 1
Function-Cost Analysis of Flat Bottom Steep

From the Figure 1, the spot 1, 2, 3, 4 are the selected ones. Therefore, electrical control structure, CO_2 suction device, sieve plates device, and loading and unloading device need to be optimized and perfected.

CONCLUSION

The application of value engineering indicates value engineering could be used in more areas than some traditional management methods, such as industrial engineering. Especially, the employment in the early stage of the product life cycle could help eliminate lots of problems in its infancy. In addition, the application of value engineering in the flat bottom steep has a certain significance and reference for some similar study of complex machinery.

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