A NEW METHOD IN FUNCTION ANALYSIS

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ABSTRACT

This paper presents five ways to improve function value by geometric analysis and by use of the area possibility derives a new method in function analysis.

INTRODUCTION

In value engineering (VE), the purpose of function analysis is to improve the value of the function or to decrease function cost greatly. As the improved object of VE activity we can by analysis and research make a new improved design which can make the function cost of products lower and raise the value of products to gain better economic benefits.

Usually, function is represented by F, the present cost to realize the function is represented by C, value of the function is V, then the formula is that V equals F divided by C.

During the analysis of real value, we often look for various alternatives for each function and use the cost of the alternates as standards to test the effectiveness of the original costs (function present cost). If we put the order of the cost from small to large, of the alternatives then we can find outthe alternative function's minimum cost (C_{min}). We call it function objective cost.

In the formula that V equals to F divided by C, the minimum cost C_{min} in the alternative can often be used as function F to define the value V, now the value V can be measured, and V equals F divided by C or theory, to C_{min} divided by C and is no more than 1.

GEOMETRIC ANALYSIS OF THE IMPROVING PRODUCT VALUE METHOD

In the plane right angle coordinate system abscissa C the represents function cost, ordinate F represents function, in the diagram "C - F", V equals, to F divided by C and to 1, is an ideal value line, and the present value of functions V which is no more than 1.

To improve the function value of products, the chosen objective should be improved, usually there are five methods: C, F, V separately represents the original, function and value before improvement, C', F', V' represents new cost, function and value after improvement, the five methods of improving the function value of products can be explained through diagrams by geometry.

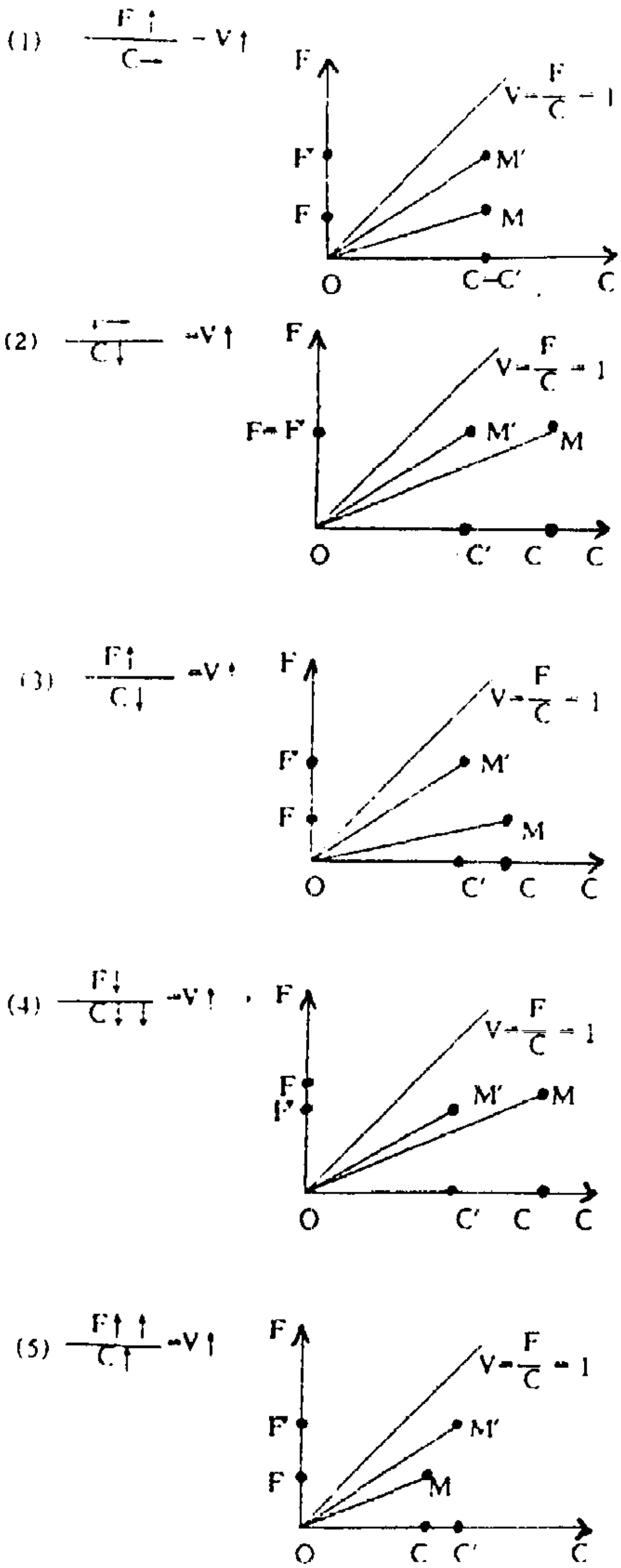

Chart 1

In the above diagram "C - F". V equals 1 is called standard valueline, the ideal situation of F = C. According to the definition of straight line slope, we can easily know that the slope of straight line OM is just equal to V=F/C; that is slope tg(a) = V, and the slope of the straight line OM' is the new value of the product after improvement V' which equals F' divided by C'; that is slope tg (a') = V.

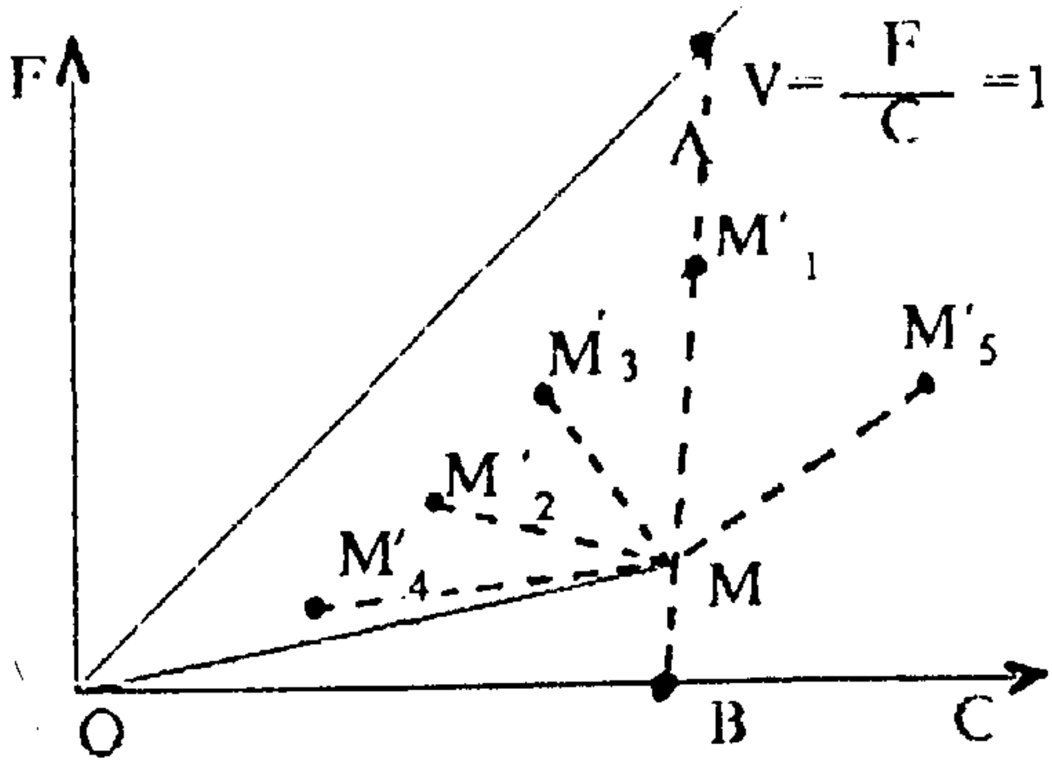

Chart 2

The purpose of VE is to improve the value of product, using geometry, that is to make the straight line OM towards the above (put the original coordinate O as a center) and gain the straight line OM' (tg(a) > tg(a'), then make the straight line OM' close to the standard value line as near as possible.

THE PRINCIPLE OF CHOOSING GOOD OF FUNCTION ANALYSIS BY DIAGRAM METHOD

In diagram "C - F", if M_i' (i=1, 2,...,5) represents the point which by the nth way to make the original value point M(C,F) of products to. Now we observe the position of M_i'in the diagram "C - F" comparatively to the value point M.

In Chart 2, point A and B is a point of intersection of standard value line V = 1 and OC axis with a vertical separately. We can see from the diagram, the new value points M_i (i=1,2,3,4) fall in the triangle (OAM) except for value point M_5' which by the fifth method improving the product value. It is quite evident that the each point of the triangle is the possible point of fall of M_i' (i=1,2,3, by C',that is slope tg(a')=V'. 4). Under the condition of not considering the fifth method (in fact,this method is not very important comparatively with the other methods of improving the product value) and in the sense of probability, the larger the area of the triangle OAM, the greater the possibility of using the VA to improve the production value, and the greater the possibility of gaining the economic benefits after improvement. Improving product value relies on improving the function value of products eventually, so if we use the above thoughts to - the improving of function value intact, we can conclude as follows:

In function diagram - "C - F", the larger the area of the triangle OAM, the greater the possibility of improving the function value.

According to this conclusion, we can make a principle which can choose the objective in VE activity: Each function in the product should be chosen from large to small according to its areawhich is formed in the diagram "C - F" of value the principle of chosen good by the method of the function analysis diagram.

THE APPLICATION OF THE METHOD OF THE FUNCTION ANALYSIS DIAGRAM

Using the method of the function analysis diagram to choose the improvement objective, you should at first account the area of value diagram OAM formed by each function, then compare and range them in order and choose them according to the requirement. If only one objective is needed, the function whose triangle area is the largest should be chosen. If many objectives are needed, the function should be chosen from large to small according to the triangle area.

Now we had better find the formula of the area of function value triangle OAM.

In diagram 2, the coordinate of point M is M(C,F), coordinate of the point A is A(C,C), coordinate of the point B is B(C,O). If S represents the area the area of triangle OAM, S_1 represents the area of triangle OAB, S_2 represents the area of triangle OMB,

$S=S_1 - S_2$
$=(AB*OB)/2 -(MB*OB)/2$
$=(C*C)/2 - (F*C)/2$
$=C*(C - F)/2$

We can know from the expression of S that the area S of triangle OAM relies not only the function present cost: C, but also the cost deviation (C - F).

If we have function F and F", the function present cost is C and C', which then forms the area of function value triangle OAM. First of all,the triangle and satisfies:

$S=C(C - F)/2$
$>S'=C'(C' - F')/2$
$C(C -F) > C'(C' -F')$

Obviously, if the above inequality is tenable, one of the following situation will appear:

1. C>C'; C-F>C'-F'
2. C<C'; C-F>C'-F'; C(C-F)>C'(C'-F')
3. C>C'; C-F<C'-F'; C(C-F)>C'(C'-F')

i.e. we have C>C',C-F>C'-F' at the same time; or C is a little smaller than C',but C-F must be much bigger than C'-F'; or C-F is a little smaller than C'-F', but C must be much bigger than C'. So when the two functions of the product are compared with each other and we want to choose one of them as an improvement objective, we should have a synthetical analysis and study each function present cost and cost deviation. we should not set one factor of them as analysis standard. If we do so, it will be reasonable and in an all-round way. Example 1. There are five functions in a product. The data of its homologous function present cost and objective cost is as follows (see table 1):

function	function Present value C($)	function objective cost F($)	function value V=F/C	function deviation C-F ($)	function value triangle area S=C(C-F)/2
F1	80	80	1.00	0.00	0
F2	120	96	0.80	24.00	1440
F3	140	118	0.84	22.00	1540
F4	35	15	0.43	20.00	350
F5	150	140	0.93	10.00	750

Table 1

If the function value is ordered from small to large, the order of choosing the improvement function objectives is: F_4,F_2,F_3,F_5.

If the function cost deviation is ordered from small to large, the order of choosing the improved function objectives is : F_2,F_3,F_4,F_5.

If the function value triangle area is ordered from small to large, the order of choosing the improved function objectives is : F_3,F_2,F_5,F_4.

However, by using the method of the function analysis diagram, calculating the area of function value triangle, choosing the improved function objective according to the order of area from large to small. This method is more reasonable and reliable than the former two methods. This method is much easier to use and has some value of application.

When the function objective cost $F=C_{min}$ isnot easily calculated, we often use the method of function relative analysis to define each function's importance coefficient F_i. After each function present cost divides by the total function cost, we can get the cost coefficient of each function C_i. Now we also can use the above method of function analysis diagram, calculate the triangle area of each function value with that S_i equals to the half of the Ci multiplied by the absolute value of C_i minus F_i, then compared them according to the order large to small, choose the improvement function objective.

Here formula S_i has a little change than the former formula S, which gets the absolute value of function cost deviation (C_i - F_i). That is because in the method of function relative analysis, some functions may show that its cost coefficient C_i is smaller than function importance coefficient F_i, which makes $(C_i-F_i)<0$, but in fact the area is not negative.

Example 2. If there are five functions in a product, each function importance - coefficient F_i gained by the method of function relative analysis, also each function cost coefficient Ci is calculated according to each function present cost; each function value coefficient $V_i=F_i/C_i$; each function value triangle area S_i is calculated according to formula and S_i which is shown in table 2.

function	function cost coefficient C_i	function importance coefficient F_i	function value coefficient $V_i=F_i/C_i$	function cost coefficient deviation $\|C_i-F_i\|$	function value triangle area $S_i = C_i\|C_i-F_i\|/2$
F1	0.06	0.08	1.33	0.02	0.0006
F2	0.24	0.29	1.21	0.05	0.0060
F3	0.42	0.38	0.90	0.04	0.0084
F4	0.18	0.10	0.56	0.08	0.0072
F5	0.10	0.15	1.50	0.05	0.0025
total	1.00	1.00	5.50	0.24	0.0247

Table 2

We can know from the data of the above table: 2 If the absolute value (V_i-V) between value coefficient V_i and standard value coefficient is ordered from big to small, the order of choosing the improving function objective is F_5,F_4,F_1,F_2,F_3. If the absolute value of function cost coefficient deviation is ordered from big to small, the order of choosing the improving function objective is F_4,F_2 (or F_5),F_3,F_1.

If the function value triangle area S_i is ordered from big to small, the order of choosing the improving function objective is F_3,F_4,F_2,F_5,F_1. In the above, we put forward a new quantitive method of choosing the improving function objective in the application of VE. This function diagram method is vivid and directly perceived through the senses, and easily calculated. If used as a standard of choosing good, it is reasonable and reliable.