4.3 Evaluation and structuring method for pre-evaluation from a rational perspective

4.3.1 Introduction

This section briefly introduces several methods, such as the Scoring method developed by J. Fasal and improved by T. Fujita, Professor of Sangyo Noritsu University; the DARE method developed by A. J. Klee; and the method to combine and select the best structured plans at once, developed by M. Esaki.

4.3.2 What is the pre-evaluation method?

To create a new object requires choosing a policy, plan, design, materials and method, and combining them to create and realize a structured plan. This requires making and comparing several plans, and then deciding which ones should be combined. The plans, however, are compared subjectively because each one is usually uncertain at pre-evaluation. A subjective comparison is likely to provide different viewpoints and lead to misunderstanding, which makes it difficult to reach a conclusion. The following methods are intended to make pre-evaluation possible in a reasonable and quick manner. It is important to remember that the results of the methods have to be checked and adjusted as a whole on the basis of the uppermost purpose.

The methods will be explained in the following order:

(1) Priority Method

(2) Scoring Method (revised) (J. Fasal/T. Fujita)

(3) DARE Method (A. J. Klee)
(4) Considerations in scoring the evaluation
(5) Rules for taking a reasonable majority decision on evaluation plans (M. Esaki)
(6) Method to immediately combine and select the best structuring plans (M. Esaki)
(7) Essentials for evaluation-based decision-making (M. Esaki)

4.3.3 Priority Method

This method is based on the general way of thinking in daily life. For example, when choosing 1 out of 3 plans, the 3 plans are ranked for each evaluation element. The ranking is added or multiplied for each plan, and priority is decided according to the result: top priority is given to the plan with the smallest result (Table 4.3-1). The former is called the addition method, and the latter is called the multiplication method. The example in the table can be easily ranked with the priority method. In this case, it becomes easier to make the final decision if the differences between the plans are quantitatively determined in advance. Our experiences have demonstrated that this method can be used in most cases.

The following methods are used when the priority method cannot provide a decisive conclusion, or when it is necessary to determine weighting coefficients for many evaluation elements.

4.3.4 Scoring Method (revised) (Table 4.3-2)

(1) This method provides the keys to rank and weight evaluation elements.
(2) Even when there are many evaluation elements, it is easy to pick and compare two elements and decide which is more important. When two elements are compared, the more important one is considered to be 1, and the less important one is considered to be 0.
(3) The reasonable consistency in weighting elements can be checked by the evaluation result.

Let's take an example of ranking the evaluation elements in the case of the air intake port of a helicopter turbo shaft engine. When there are 4 evaluation elements, as shown in Table 4.3-2, 6 decisions have to be made ($_4C_2$ times = 4 x 3/2 = 6).

It is important to rank the elements so that their scores in the table are ranked starting from 0, 1, 2, 3, and so on. If not, no consistent algorithm exists in the pair comparison, as shown in Table 4.3-3. Such evaluation elements should be reconsidered, or new pairs of evaluation elements should be added to

maintain the algorithm. In Table 4.3-3, the lack of a consistent algorithm is readily recognized because A is inferior to C in spite of the decisions of A>B and B>C. This is a good example of how clearly the score of the table shows the lack of a consistent algorithm.

Table 4.3-4 shows an example in which the upper and side air inlets of a twin-engine helicopter are compared to determine the remodeling elements of the engine. The weighting coefficients obtained in Table 4.3-2 were used. The comparison yielded the decision that the side inlet was superior to the upper inlet by 2.5 times because the overall score of the former was 95, whereas that of the latter was 38 (95/38=2.5).

4.3.5 DARE (Decision Alternative Ratio Evaluation) Method

This subsection first describes an example that can be generally applied and expanded, and then discusses the applied evaluation example of engine air inlets.

(1) Example of refuge disposal facilities in Table 4.3-5

First, the evaluation elements are randomly arranged in column A. Each element is compared with that over it in terms of importance, and the subjectively determined relative importance ratios are recorded in column B. For example, when the operation cost is 1, the development period is 1.3 times more important than the operation cost, and air pollution is 2.5 times more important than the development period.

In column C, the base value of 1.0 for the bottom element (operation cost) is first recorded. The value is multiplied by the relative importance ratio in the upper element row (development period) in column B, and the result is recorded in the corresponding space of the element in column C.

Column D indicates the ratio of each element to the total of column C when the total is 1.0. Evaluation is made using the ratio of each element as a weighting coefficient, as shown in Table 4.3-4. This procedure is the DARE Method.

Table 4.3-6 shows another application of this method. The table compares the two plans of Table 4.3-4 by the ratio when the score of the side inlet is 1. In this case, the weights in Table 4.3-2 were used. As a result, it was concluded that the side inlet was about 2 times as valuable as the upper inlet. This indicates that there was no difference in the priority between the two tables (Table 4.3-2 and Table 4.3-6) even though the importance ratio was different. That is, the top priority element did not change when the method changed, and the rankings were also almost the same.

4.3.6 Considerations in scoring the evaluation

The preceding subsections described subjective evaluations. However, when evaluation is difficult because the subjects to be compared are close, a graph as shown in Figure 4.3-1 is useful. The graph can be used to make weighting inclination curves.

4.3.7 Rules for taking a reasonable majority decision on evaluation plans

These rules can be applied to any of the above methods when a majority decision is required. This subsection explains the rules by taking the case of the priority method using a majority decision in Figure 4.3-2.

(1) List the plans to be evaluated, for example, on a blackboard so that (many) voters can see them. Call each plan the 1st, 2nd, 3rd etc,… plan.
(2) The chairman requests the voters to rank all the plans on a piece of paper. The voters must give rankings on this piece of paper instead of presenting their opinions.
(3) After the voters have finished, the chairman records the rankings to the right of each plan as in Fig. 4.3-2. When a majority decision does not produce an almost consistent ranking, the voters who presented far different rankings must explain their reasons so that differing opinions can be considered and adjusted. If necessary, voting is repeated.
(4) After presentation and adjustment by all the voters or additional voting has finished, the score of each plan is totaled, and the resultant ranking of the plans is considered to be the majority decision.
(5) However, when plans with low scores are close in score, a majority decision is taken once again only for them.
(Note) In (3) to (5), when it is difficult to rank the plans, give the plans the same rank. Give the plans every one or two skips, such as 1, 3, and 5 when the difference of the plans needs to be exaggerated.
(Note) When the rules are applied to the DARE Method, simply replace the priority ranking with the ratio values.

4.3.8 Method to immediately combine and select the best structuring plans

This method is efficient when the structured plans to be evaluated can be combined in several ways, and the combination and the selection of the best ones need to be made quickly. That is, this method is efficient

when several structured plans can be made by combining elements, and the combination has a decisive effect on the result. For example, this method is effective when the roles of project members must be decided at the start of a project.

Figure 4.3-3 shows an example of how to decide the roles of project team members by mutual election.

(1) The necessary roles of the team, such as team leader, sub-leader, secretary, and general affairs, are listed so that all the members can see them.

(2) The deciding chairman requests all the members to think of the best combination of the members and roles. The members should first write down their ideas on a piece of paper instead of presenting them orally.

(3) After all the members have finished, each member should present his/her idea, and the chairman records them to the right of the listed roles.

(4) After the presentations, write the total score of each member for each role at the rightmost part of the list. The roles are decided when each role has a member with the highest score for that role.

(5) When there are two candidates with the same score for a particular role, voting is done again for these roles. Then, voting is performed for the remaining roles.

4.3.9 Essentials for evaluation-based decision-making

Although many evaluation techniques have been published, all of them provide only the result of "Difference of Information by Simple Comparison" for decision-making, and forget to emphasize that pieces of "Structured Difference of Information", in which importance is given to the purpose-measure relation (direction of value), should be put together.

A correct decision should be made by the mechanism explained in "Decision-making mechanism based on difference of information," and the following items should be confirmed before discussing evaluation techniques.

(1) Decisions should be made based on the relation between purpose and measures. Persons concerned with decision-making in a complicated evaluation should make a "block diagram of purpose and measures" using the PMD method as needed.

(2) Because decisions are made on the basis of the "difference of information," it is desirable to compare the plans to be evaluated with numerical values.

(3) Because all the ranking and weighting activities for evaluation should be based on the relation between purpose and measures, a "block diagram of purpose and measures" using the PMD method should be referred to.

Because comparison can be made only between 2 subjects, even when comparing more than 3 plans, it is desirable to make the final decision between 2 plans as early as possible. This is because only one piece of "information of difference" is necessary to compare 2 plans, while 3 pieces of "information of difference " are necessary to compare 3 plans. This is confusing for those concerned.

Decisions should be made for future activities. The six conditions in Figure 4.3-4, including the above description, are required.

Making the best use of the evaluation techniques requires collecting and preparing the necessary information in advance.

4.3.10 Discussion

This chapter describes simple, reasonable, and practical methods for pre-evaluation from a rational perspective. Although there are other good methods, such as the Analytical Hierarchy Process Method briefly explained in Section 3.1, they are not discussed in this chapter because they select one plan only after ranking many plans, and are, therefore, not efficient in terms of time and work.

"Considerations in scoring the evaluation" of subsection 4.3.6 and "Rules for taking a reasonable majority decision on evaluation plans" of subsection 4.3.7 come from the author's own thinking and have never been published by anyone else. The author has used the procedures of the two subsections in his practical work. These methods are introduced in this chapter because they assist the DTCN method, and are required in the Design To Cost Method in Chapter 6 and later on. As described in Section 3.1.9f, the above-mentioned evaluation methods are more effective when combined with the PMD Method. The PMD method is effective and reasonable as a way to reach a situation where the above methods can be used properly.

Tabe 4.3-1 Example of priority method

Evaluation element / Plan	Cost Priority	Weight Priority	Reliability Priority	Feasibility Priority	Total Count	Notes	Total priority
Plan A	2	1	1	1	5	Cost difference between plan A and plan B is very small	1
Plan B	1	3	2	3	9		2
Plan C	3	2	3	2	10		3

Table 4.3-2 Priority of evaluated elements to select the engine air inlet port direction for a twin-engine helicopter

Evaluation element (A)		Judgment (B)						Count (C)	(C)+1 (D) Note	Importance (E)
		1	2	3	4	5	6			
1	Aerodynamic resistance	0	0	0				0	1	0.1
2	Maintenance on aircraft	1			1	0		2	3	0.3
3	Installation and removal of engine		1		0		0	1	2	0.2
4	Foreign object defect (FOD)			1		1	1	3	4	0.4
								Total	10	1.0

(Note) Originally Fasal started the priority from zero.
T.Fujita improved the method by adding "1" to the Fasal result in order to avoid dividing zero when getting a weighting coefficient.

Table 4.3-3 Example of no algorithm in "0-1" comparison

Evaluated element	Judgment			Count
	1	2	3	
A	1	0		1
B	0		1	1
C		1	0	1

Table 4.3-4 Comparison result for selecting the air-inlet direction for helicopter engine

Evaluation element		Aerodynamics (Resistence)		Maintenance onboard		Installation maintenance		Foreign object defect		Total score
Weight		0.1		0.3		0.2		0.4		
Plan		Score	Score × weight coeff.	Score	Score × weight coeff.	Score	Score × weight coeff.	Score	Score × weight coeff.	
1	Upper inlet	80	8	20	6	100	20	10	4	38
2	Side inlet	50	5	100	30	100	20	100	40	95

Table 4.3-5 Example of DARE-Method

Column A Column B Column C Column D

Evaluated element	Ratio when compared with "C" column of next low row	Ratio when compared with lowest "C" column row(1.0)	Weight
1. Initial investment	2.0 →	0.66	0.10
2. Salvage value	0.1 →	0.33	0.05
3. Air pollution	2.5 →	3.25	0.50
4. Development period	1.3 →	1.3	0.20
5. Operation cost	——	1.0	0.15
Total		6.54	1.0

Table 4.3-6 The result of compared evaluations when side inlet(plan) is "1.0"

Evaluation element		Aerodynamics (Resistance)		Maintenance onboard		Installation and removal of engine		Foreign object defect		Total Score
Weight		0.1		0.3		0.2		0.4		
Evaluation plan		Ratio score	× weighting coeff.	Ratio score	× weighting coeff.	Ratio score	× weighting coeff.	Ratio score	× weighting coeff.	
1	Upper inlet(plan)	1.5	0.15	0.5	0.15	1	0.2	0.1	0.04	0.54
2	Lower inlet(plan)	1	0.1	1	0.3	1	0.2	1	0.4	1.00

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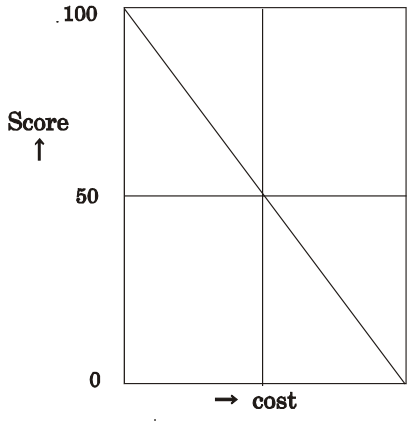
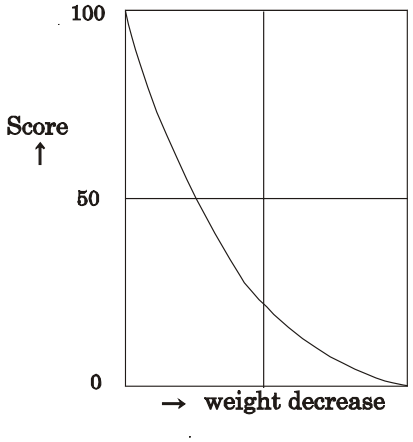
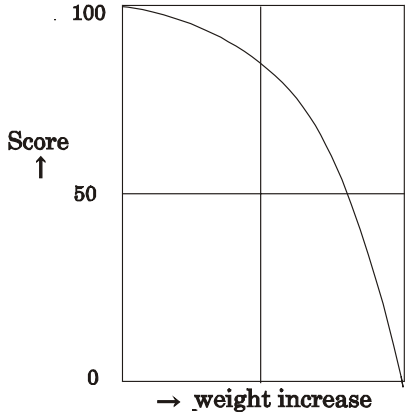
Fig. 4.3-1 Weight inclination curve



(1) Proportional relationship



(2) Exponential relationship



(3) Inverse exponential relationship

Fig. 4.3-2 Rationale rule to decide the evaluated plan by the majority
(In order to keep the importance of majority opinion, because sometimes majority opinion is the more important)

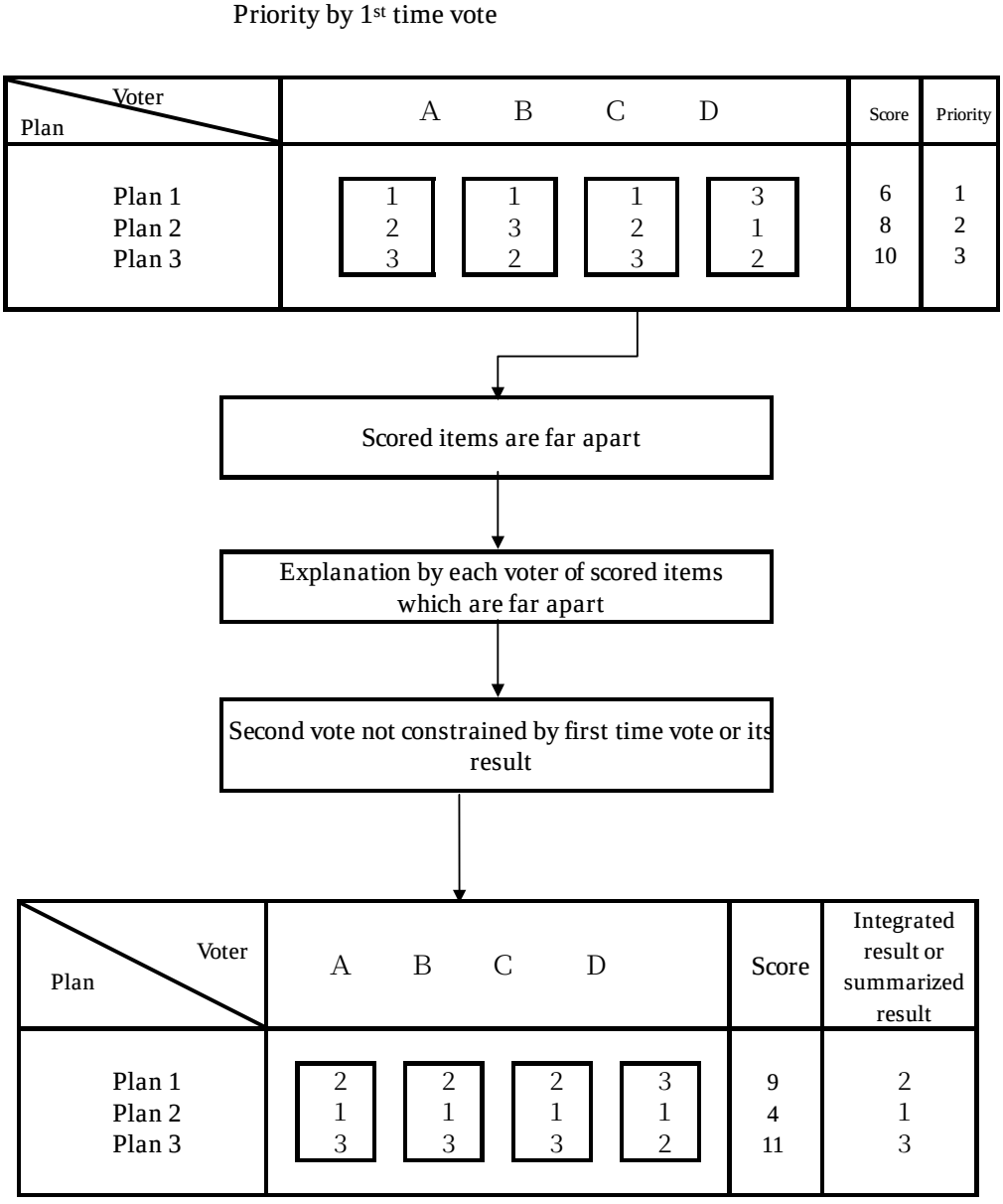
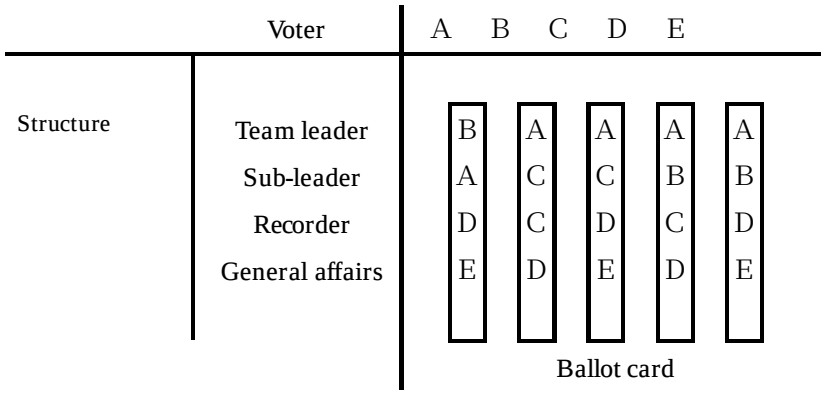


Fig.4.3-3 Method to create the plan of structure and to select it at the same time (by the example of a mutual vote)

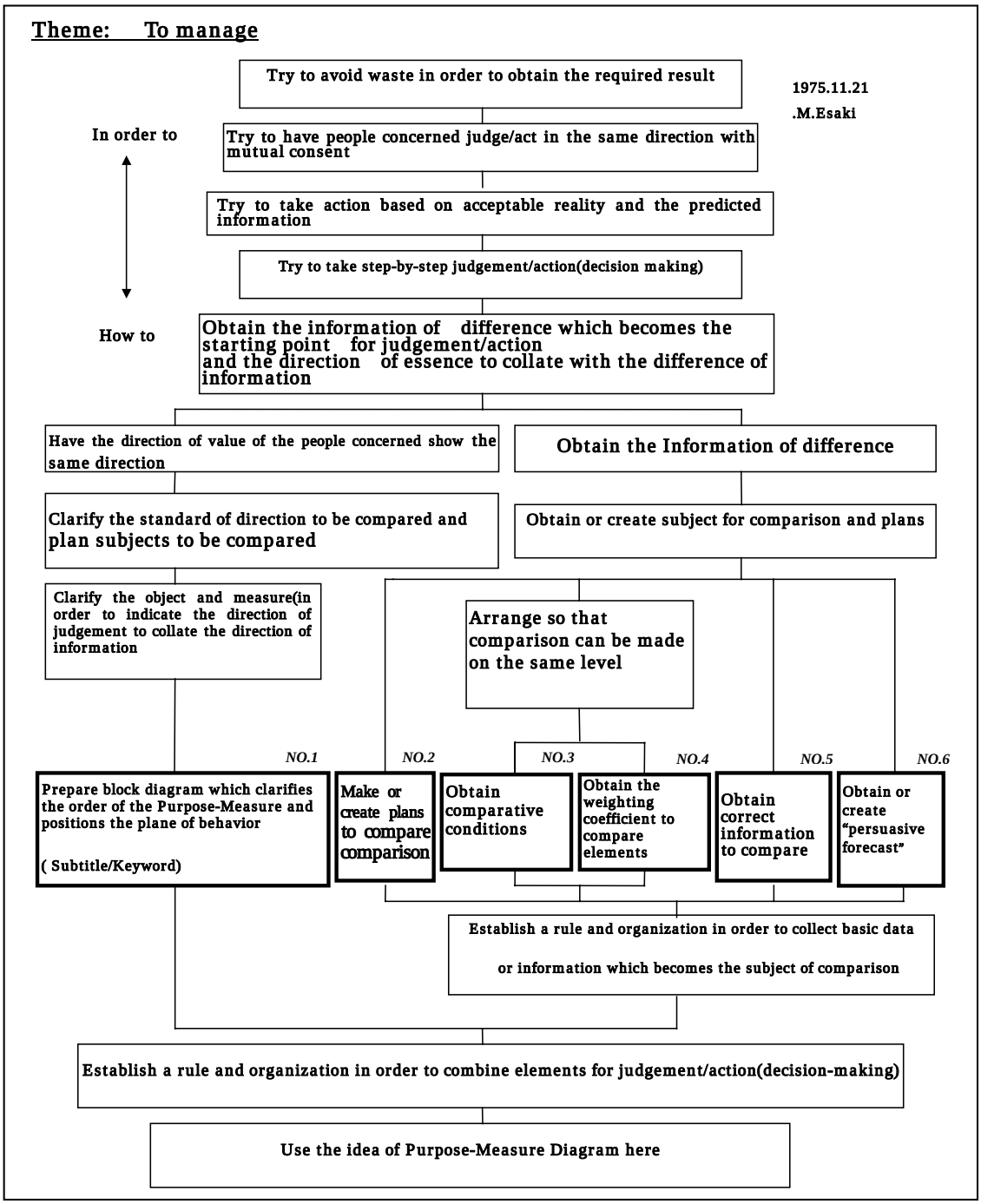


Voting results written on black board

	Role	A B C D E	Summery
First time voter	Team leader Sub-leader Recorder General affairs		"A" decided because of super majority Re-vote assuming "A" is leader
2nd time voter	Sub-leader Recorder General affairs		"B" is decided "C" is decided "D" is decided

Fig.4.3-4 Essential conditions for decision-making in management

Purpose-measure diagram shows six required conditions for decision-making in management



Episode 12 Explanation of ambiguous terms

In Episode 2, it was shown that PMD can be used to study language. In this episode, some ambiguous terms and their uses will be explained for practical work.

(1) What is “to examine”?

The word “examine” is commonly used, but it is not easy to clarify what it means.

To examine is to consider two or more alternatives, and compare them to select the best one among them.

The above “to consider two or more alternatives” includes “to consider to do or not to do.” The terms “verify” and “evaluate” are used for the examination. In the following paragraphs, the contents and purposes of verification and evaluation will be discussed.

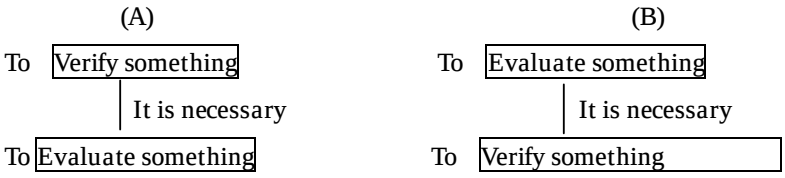
(2) To verify

The word “to verify” is easily used, but its contents are not always clear. This is particularly true when it is necessary to verify a future issue. To solve the problem, it would be better to first clarify whether the word “verify” is used for a future or past issue because the steps for verification are completely different between future and past issues. The meaning of “to verify a past issue” is easily understood. One of the clearest examples is to verify a crime. All you have to do is to prove the facts that only the criminal knows, using evidence, alibis, and witnesses.

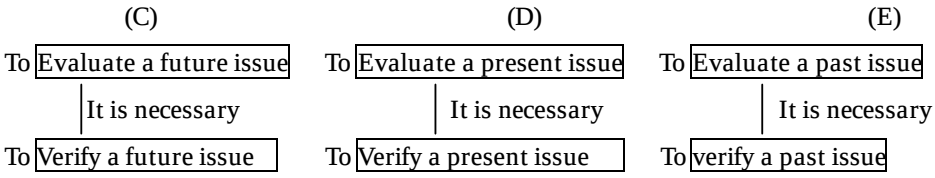
What are the contents of “to verify a future issue”? There is no physical evidence because the issue belongs to the future. Therefore, “to verify a future issue” is to use previous trends, independent ways of thinking, or insert conditions to make people believe that the issue will be solved, that is, to make up a structure that leads people to recognize the steps and procedures to solving the issue. The structure is used to obtain their understanding. This interpretation is the same as the contents of the “Persuasive prediction” in the Chapter “Decision-Making Mechanism by Difference Information.”

(3) Relation between the terms, “verify” and “evaluate”

The relation between the terms “verify” and “evaluate” can be expressed through PMDs as follows:



Which is the more reasonable order? If both seem reasonable, it would be due to the lack of proper use of past and future verification. The following figures show the PMDs for future evaluation and verification, present evaluation and verification, and past evaluation and verification:



The word “to evaluate” includes future, present, and past aspects. Therefore, “to verify” is also used properly for future, present, and past aspects. Future verification is to persuasively explain future possibilities; present verification is to confirm and explain current status; and past verification is to prove a theory with evidence. Both “verify” and “evaluate” have completely different steps for future, present, and past issues.

(4) Let's think about the word “evaluate,” in detail, in terms of future, present, and past aspects. Because it is a known fact that evaluation is done before a decision has been made, “evaluate” is interpreted here as a pre-decision evaluation. Decision-making is done for a future issue. Therefore, to make a decision for a future issue requires evaluating a future issue (future evaluation).

In general, the term, “evaluate,” is used to decide something good or bad, or to make a relative evaluation by weighing and scoring various factors. “Evaluate” is the combination of “E” or “Ex” and “valuate,” and therefore includes the meanings of to “create a value” and “emphasize a value.” Therefore, to make a future evaluation is to create a future value,” and value creation is possible only when there is the relationship between purpose and measures, as described in the section on the decision-making mechanism.

In other words, to make an evaluation (to create a value) is possible only when there is a relationship between purpose and measures (PMD). Therefore, it is meaningless to evaluate something by scoring and decision-making unless discussion is done in advance on the basis of a PMD (purpose-measure diagram).

Conclusion

In conclusion, to make a future evaluation is to prepare a PMD showing the relationship between purpose and measures in the future, and compare and evaluate alternatives at the Key Word level of the PMD.