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Decision Procedure Models and Empirical

Research: A Case of Japanese Firms

by

Nobuo Takahashi
and
Satoru TAKAYANAGI

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Satoru Takayanagi

Doctoral Program in Socio-Economic Planning

and

Institute of Socio-Economic Planning

The University of Tsukuba

Sakura, Niihari, Ibaraki 305, JAPAN

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Abstract

This paper considers a new typology of decision procedures, the "fixed-size procedure" and the "sequential procedure," associated with the way of discovering of new alternatives. We discuss simple decision process models of these decision procedures, and hypothesize that decision makers with the sequential procedure search the smaller number of alternatives than ones with the fixed-size procedure. Our empirical research on Japanese firms supports this hypothesis, and we obtain the findings; when faced with greater uncertainty, the fixed-size procedure firms take organizing modes to increase information processing capacity, and the sequential procedure firms take ones to decrease the need for information; the fixed-size procedure firms take "Japanese" conflict resolution modes but the sequential procedure firms not. Thus we are to provide a new point of view for the study on decision processes and Japanese management methods.

1. Introduction

The pioneering work of Simon (1947) initiated the studies on
decision processes in the organizational context (e.g., Cyert, Simon,
and Trow, 1956; March and Simon, 1958; Cyert and March, 1963; Simon,
1970; 1977; Newell and Simon, 1972; Cohen, March, and Olsen, 1972;
etc.). Mintzberg, Raisinghani, and Theoret (1976) classified the
research on decision processes into three groups; research by cognitive
psychologists on individual decision making, research by social
psychologists on group decision making, and research by management
theorists and political scientists on organizational decision making.
We study the organizational decision processes from the viewpoint
of the cognitive research on individual decision making of their
classification by introducing of a new typology of decision procedures,
the "fixed-size procedure" and the "sequential procedure."

In accordance with the classical rational decision making method,
a decision maker is described as going through a set of processes
where he (1) identifies and systematically orders objectives and
values, (2) surveys possible alternatives of achieving those values,
(3) exhaustively examines their sequences, and (4) makes a choice
that reaches some acceptable level of achievement (cf. Lindblom,
1959; 1968; March and Simon, 1958). Our decision procedures is mostly
concerned with (2).

To be exact, a "decision procedure" defines the way of discovering of new alternatives and stopping of the discovering process: When the fixed-size procedure is taken, the decision maker comprehensively surveys the fixed-size possible alternatives before (3) and (4); when the sequential procedure is taken, he searches an alternative at a time, and accepts this alternative if it reaches the level, and rejects it and returns to (2) if not.

The purpose of this paper is to introduce this new typology of decision procedures into identifying organizational decision processes and to relate these decision procedures to the management patterns in the organizations. To attain the objectives, we give the precise definition of these decision procedures and a fundamental hypothesis is derived by using simple models of the decision procedures (Section 2). This hypothesis is supported by our empirical research on the case of Japanese firms (Section 3). Our empirical research is accompanied with interesting findings that relate the decision procedures to conflict resolution and organizing modes (Section 4). We propose our interpretations of these findings (Section 5) and discuss the implication of the results for Japanese management (Section 6).

In (4) of the set of processes, we assume the decision maker to choose the alternative that reaches some acceptable level, that is, we assume satisfactiry standards. Cyert, Simon, and Trow (1956), and March and Simon (1958) gave the precise definition of satisfactory standards, and compared the satisfactiry alternative with the optimal alternative. They stated that most human decision making is concerned with the discovery and selection of satisfactory alternatives; only in exceptional cases it is concerned with the discovery and selection of optimal alternatives. Therefore, we focus on the ways of discovering and selecting of satisfactory alternatives as indicated in (4) of the set of processes.

2. The Models

We introduce two types of decision procedures, the fixed-size procedure and the sequential procedure which are well-known sampling procedures in statistical situation (Blackwell and Girshick, 1954; DeGroot, 1970; Lippman and McCall, 1976). The decision maker is called to take the fixed-size procedure if he firstly discovers the set of possible alternatives whose size is fixed in advance, and secondly select a satisfactory alternative from this set. On the other hand, if the decision maker discovers alternatives in sequence, and at each stage he searches an alternative and decides on the basis of the information thus far collected whether to stop searching and select the alternative or to discover another alternative at least, then he is called to take the sequential procedure.

To describe the underlying property of these decision procedures, we make the decision process models, and compare the fixed-size procedure with the sequential procedure. First, we build the decision process model in the case of the fixed-size procedure. For the i-th alternative, let X_i be the random variable which has value 1 if the i-th alternative is satisfactory and 0 otherwise. Let S_i be the sample space of the random variable X_i then $S_i = \{0,1\}$ i=1,2,...,s, where s is the number of the alternatives under consideration which is fixed in advance. The space of outcomes S consists of the 2^s points, and

$$S = S_1 \times S_2 \times \cdots \times S_s,$$
$$x = (x_1, x_2, \ldots, x_s) \in S.$$

Let m denote the number of coordinates that have value 1 in x. Since the decision maker takes the fixed-size procedure, he accepts some satisfactory alternative if m>0, and rejects all s alternatives if m=0.

In most real situations, discovery of alternatives is costly, and the decision maker might greatly improve his situation if at each stage he balances the cost of searching future alternatives against the expected gain of alternatives from such a search process. In fact, the decision maker can economize on time, transactions costs, search costs, and information processing costs necessary to discover and select alternatives if the alternatives are discovered one at a time and appropriate decision are made as soon as the action, to accept the alternative and to reject it, becomes known. Thus, the decision maker can economize on time and resources by taking the sequential procedure.

To illustrate the merit of the sequential procedure, we show that it reduces the number of alternatives which are consequentially examined. For example, let s=5, in the case of the fixed-size procedure, the decision maker must always search and estimate five alternatives, but in the case of the sequential procedure, the decision maker must search and estimate five alternatives only if two outcomes of $2^5=32$ points of S occur;

(0,0,0,0,0), (0,0,0,0,1).

To be exact, the expected number of alternatives in the case of the sequential procedure is given by

$$EN=\sum_{n=1}^{5} n(1-p)^{n-1}p+5(1-p)^5,$$

if X_i's are independent and identically distributed random variables, and $p=Pr\{X_i=1\}$. From this expression, EN=5 only if p=0, and EN<5 if p>0. In most real situation, the probability p that an alternative discovered by the decision maker is satisfactory is not zero, then the expected number of alternatives in the case of the sequential procedure is always less than that in the case of the fixed-size procedure. Thus the sequential procedure reduces the number of alternatives to be discovered in comparison with the fixed-size procedure. If p=0.25, then EN=3.051 and we can save about 40% of the number of alternatives by taking the sequential procedure. In general cases that p>0, EN<s can be proved as follows:

$$EN=\sum_{n=1}^{S} n(1-p)^{n-1}p+s(1-p)^S$$

$$<\sum_{n=1}^{S} s(1-p)^{n-1}p+s(1-p)^S$$

$$=s(1-(1-p)^S)+s(1-p)^S$$

$$=s.$$

We are now in position to propose the following important hypothesis.

Hypothesis 1. The decision maker who takes the sequential procedure searches the smaller number of alternatives than the decision maker who takes the fixed-size procedure.

This hypothesis characterizes an important and underlying aspect of decision procedures, and will play a key part in the interpretation of our findings in Section 5. Organizations probably use both decision procedures at one time, but each decision maker in the organizations use one at a decision opportunity even if he shifts between decision procedures in a long term. The decision procedure taken by a decision maker can be essentially classified into one of two at a decision opportunity although decision processes within organizations are messy and ill-defined. Our typology is useful enough for the analysis of a decision maker's process at one time.

3. Methods and Results

Methods

This study focused on the decision procedures of the large Japanese firms listed on the Securities Exchanges (N=299), and the research was carried out in January 1983. This article reports on data obtained from the mailed questionnaires, each of which is addressed to a planning manager of the head office at a firm.

Actual respondents include 3 managing directors, 28 general managers, 24 assistant general managers, 80 managers, 9 assistant managers, and 25 subsection heads. The respondents were asked to report the kind of the decision procedure and the number of alternatives under consideration for "the latest decision at removal or newly establishment of a factory, a branch, and an office," since such decisions on location plans are common in every industry.

To test Hypothesis 1, the respondents answered the following question about their latest decision (the original questionnaire is written in Japanese).

Question 1. (1) When your organization decided the latest location plan at removal or newly establishment of a factory, a branch, and an office, which type of decision procedure was taken? Please circle an item of:

(a) First, plural number of alternatives were made, and secondly, one of them was chosen after simultaneous consideration.

(b) Alternatives were made and chosen in sequence, that is first of all, an alternative was made and considered and then chosen if it was satisfactory, and if not, another alternative was made and ... .

(2) How many alternatives did you consequentially consider in this decision process about the location plan? Please indicate the number of alternatives. _____

This question uses the categories of decision procedures; (a) in (1) means the fixed-size procedure and (b) the sequential procedure.

Results

Table 1 compares decision processes for the fixed-size procedure and ones for the sequential procedure in Japanese firms.

INSERT TABLE 1 ABOUT HERE

The proportions of the fixed-size procedure and the sequential procedure are summarized, and 58.4% of total firms take the fixed-size procedure and 41.6% the sequential procedure. Especially, 73.7% of Banking answered to take the fixed-size procedure, and 75.0% of Construction the sequential procedure.

In all industries except Construction, Wholesale and Retail Trade, the mean numbers of alternatives in the case of the sequential procedure are less than that in the case of the fixed-size procedure. The mean number of alternatives in the case of the fixed-size procedure is 4.77, and 3.16 in the case of the sequential procedure in total. To test Hypothesis 1, Table 2 compares, by t-tests, the mean numbers of alternatives for different decision procedures.

INSERT TABLE 2 ABOUT HERE

The mean number of alternatives in the case of the sequential procedure is significantly less than the mean number of alternatives in the case of the fixed-size procedure in total and manufacturing industry. Therefore Table 2 supports our hypothesis.

4. Findings

In Sections 2 and 3, we derive Hypothesis 1 from analysis of simple decision process models, and our empirical data support this hypothesis. We simultaneously asked other questions in the questionnaire, and obtain interesting findings as to the relationship between the decision procedures and the management patterns. Our findings relate the decision procedures to conflict resolution and organizing modes.

Conflict Resolution Modes

We investigate the conflict resolution modes which were studied by March and Simon (1958) and Lawrence and Lorsch (1967). We modified the dimensions in order to fit the actual modes in Japanese firms, and each respondent answered the following question:

Question 2. On the modes below, please indicate the mode of resolution taken for interdepartmental conflict:

(a) Resolution through debating on the issue in the conference.

(b) Resolution by formal terminal decision on mutual agreement obtained through informal negotiations.

(c) Resolution by the common superior.

Item (b) is referred to as "nemawashi (root binding)" in Japanese, which is a generally known mode of conflict resolution in Japan. Since we investigated the mode of resolution taken for interdepartmental conflict, this question was intended for only manufacturing firms.

·Table 3 suggests a tendency that the fixed-size procedure firms take conflict resolution modes of conference and "nemawashi," and that the sequential procedure firms take conflict resolution modes by a common superior. This relevance is statistically significant at p=0.0009.

INSERT TABLE 3 ABOUT HERE

Hence we obtain the following finding.

Finding 1. The fixed-size procedure firm takes conflict resolution modes through the decision processes jointly made by many persons, and the sequential procedure firm takes conflict resolution modes through the decision processes by a single person.

In other words, much of the fixed-size procedure firms take so-called Japanese conflict resolution modes, "nemawashi" and conference, which were characterized as Japanese management methods by Pscale (1978) and Ouchi and Johnson (1978). Much of the sequential procedure firms take conflict resolution modes by a single powerful superior, which were characterized as American management methods by them.

Thus, Table 3 implies that the fixed-size procedure firms take Japanese methods, and that the sequential procedure firms take American methods. In fact, as illustrated in Table 1, 58.4% of investigated Japanese firms' respondents take the fixed-size procedure, and in all industries except Construction, the number of the fixed-size procedure firms is greater than that of the sequential procedure firms.

Organizing Modes

Galbraith (1973; 1977) thought that the organization could take organization design actions when confronted with uncertainty. First, the organization can act in two ways to reduce the need for information processing; (a) creation of slack resources (b) creation of self-contained tasks. And second, the organization can act in two ways to increase its capacity to process more information; (c) investment in vertical information systems (d) creation of lateral relations. The organization must adopt at least one of the four actions when faced with greater uncertainty. We call these design actions "organizing modes."

These organizing modes were questioned by using Galbraith's categories. For the production, sales, research, and corporate division, the respondents of the manufacturing firms answered the following question.

Question 3. Please indicate an organizing mode most frequently taken when your organization was confronted with the coordination problem arised from great uncertainty:

(a) To reduce performance levels for each organization unit, that is, to form additional time that the consumer must wait and to form in-process inventory.

(b) To change the task design for each group to have all the resources necessary to perform its task, e.g., to create groups around product lines, each of which would contain the input resources necessary for the task.

(c) To create systems that collect information at the point of origin and communicate it to the appropriate places in the organization, e.g., to employ computers, assistants-to.

(d) To employ lateral decision processes which cut across lines of authority, and to remove the level of decision making down to where the information exists.

In this question, item (a) means creation of slack resources, (b) creation of self-contained tasks, (c) investment in vertical information systems, and (d) creation of lateral relations.

Table 4 suggests existence of statistically significant relevance between the decision procedures and the organizing modes except for the production department.

INSERT TABLE 4 ABOUT HERE

First, for the sales department, much of the firms taking the fixed-size
procedure answered with (d), and much of the sequential procedure firms
answered with (a) or (b). Second, for the research department, much
of the fixed-size procedure firms answered with (d), and much of the
sequential procedure firms answered with (a). Finally, for corporate
division, much of the fixed-size procedure firms answered with (c),
and much of the sequential procedure firms answered with (a) or (b).
These results are summarized in Table 5.

INSERT TABLE 5 ABOUT HERE

Thus, the fixed-size procedure firms take organizing modes to increase
information processing capacity and the sequential procedure firms
take organizing modes to reduce the need for information processing.
Thus from Tables 4 and 5, we obtain the following finding.

Finding 2. When faced with greater uncertainty, the fixed-size
procedure firm takes organizing modes to increase information
processing capacity, and the sequential procedure firm takes organizing
modes to reduce the need for information processing.

Table 6 suggests another support to this conclusion, that is,
much of the fixed-size procedure firms have on-line computer systems
but much of the sequential procedure firms have other kinds of computer
systems.

INSERT TABLE 6 ABOUT HERE

This result is evidence that the fixed-size procedure firms take
organizing modes to increase their capacities to process information
by better information systems.

5. Discussion

First, we discuss Finding 1 on conflict resolution modes.
Hypothesis 1 suggests that the sequential procedure can economize
on time and resources for decisions if time and resources consumed
at each stage of discovering an alternative is equal for different
decision procedures. But when many persons take part in the decision
process, they must hold meetings and must negotiate with other members
through more messy and complex communication channels at each stage
in order to agree with an alternative. Thus the sequential procedure
spends more time and resources at each stage, then the advantage of
the sequential procedure disappeares in the joint decision making
cases. In order to take advantage of the sequential procedure, ideally
speaking, the number of the persons associated with the decision had
better be reduced to one.

Conversely, when it is necessary for the organization in order to make many persons take part in the decision process, the advantage of the sequential procedure disappears. In such a case, a basic plan of the possible alternatives for discussion should be prepared by someone in advance of many persons' decision process in order to save time and resources to be consumed for the decision process. Thus the organization in which many persons need participate in a decision will take the fixed-size procedure.

Therefore, if the sequential procedure is taken, then a decision process should be carried out by a single person, and if there exists necessity of joint decision making by many persons, then the organization should take the fixed-size procedure. From these reasons, Finding 1 is interpreted as a conflict resolution modes aspect of the fact indicated by Hypothesis 1.

Next, we discuss Finding 2 on organizing modes by using of Hypothesis 1 and Finding 1. In the case of a single decision maker, the bounded rationality (Simon, 1947; March and Simon, 1958) of the decision maker requires to reduce the amount of information processing to within his bounded capacity to process information, and the organization must take organizing modes to reduce the need for information processing.

On the other hand, when a decision is jointly made by many persons, in order to facilitate the joint decision making, they need the communication and the shared high-quality information, which are attainable by good information systems and good lateral relations. In other words, the organization must take organizing modes to increase its capacity of information processing.

Therefore, if Hypothesis 1 is true, from Finding 1, the fixed-size procedure firms should take organizing modes to increase information processing capacity, and the sequential procedure firms should take ones to decrease the need for information processing. Finding 2 is interpreted as an organizing modes aspect of the fact indicated by Hypothesis 1 and Finding 1.

6. Implication for Japanese Management

Table 3 suggests that the fixed-size procedure firms have "Japanese" conflict resolution modes for interdepartmental conflict, and Takayanagi (1974) pointed out that the decision processes of Japanese firms were characterized by the fixed-size procedure. But Table 1 revealed that 41.6% of total firms take the sequential procedure in Japan. Why are only the fixed-size procedure firms said to have Japanese characteristics? The reason is suggested by Table 7, that is, much of the firms listed on the First Section of Tokyo Securities Exchange take the fixed-size decision procedure.

INSERT TABLE 7 ABOUT HERE

This tendency is recognized in the manufacturing industry, in the non-manufacturing industry and especially in the high-performing firms, where categories of high-performers and low-performers base on self-estimations by respondents. We objectively confirmed the validities of self-estimations by the financial ratio analysis.

The firms listed on the First Section of Tokyo Securities Exchange must satisfy the high-level initial listing requirement and they are the biggest firms of Japan. Thus Table 7 indicates a tendency that representative firms of Japan take the fixed-size procedure and that especially excellent ones do. Since researchers often studied Japanese management methods on the basis of a small sample of Japanese firms, they intended to pick up the firms from among the representative and excellent firms. Thus they have frequently observed the fixed-size procedure firms when they studied Japanese firms.

Why do much of the firms listed on the First Section of Tokyo Securities Exchange take the fixed-size decision procedure? We cannot give a certain answer for this question, and perhaps this relevance may be accidental. Future research can also focus on the question.

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Industry	Decision Procedure*		Mean Number of Alternatives**		Number of Observation
	Fixed-Size	Sequential	Fixed-Size	Sequential	
Construction	25.0	75.0	2.40	2.79	27(19)
Food and Kindred Products	53.8	46.2	2.86	2.33	16(13)
Textile Mill Products	66.7	33.3	2.63	2.00	12(12)
Paper, Chemical and Petroleum Products	66.7	33.3	5.31	3.00	30(23)
Iron, Steel and Nonferrous Metal	63.2	36.8	3.08	3.00	23(19)
Nonelectrical Machinery	60.0	40.0	2.94	2.83	36(29)
Electrical Machinery	52.6	47.4	3.90	3.44	25(19)
Transportation Equipment	60.0	40.0	4.33	2.25	12(10)
Precision Machinery	66.7	33.3	3.33	2.00	11(8)
Wholesale and Retail Trade	53.8	46.2	3.00	4.78	28(23)
Banking	73.7	26.3	17.58	5.75	22(16)
Insurance	60.0	40.0	3.81	3.34	16(13)
Public Utility	62.1	37.9	3.76	2.88	41(25)
Total	58.4	41.6	4.77	3.16	299(229)

*Expressed in percentage terms.   **Numbers of effective samples are within parentheses.

Table 1. Decision procedures and mean numbers of alternatives of Japanese firms by industry.

	Decision Procedure		Significance*	Number of Effective Samples
	Fixed-Size	Sequential		
Total	4.77(9.19)	3.16(2.31)	p=0.052	229
Manufacturing Industry	3.56(3.47)	2.78(1.27)	p=0.057	152
Non-Manufacturing Industry	6.82(14.27)	4.12(3.71)	n.s.	77

*t-tests

(Standard deviations are within parentheses)

Table 2. Mean numbers of alternatives for different decision procedures.

Decision Procedure	Conflict Resolution Mode			
	Conference	"Nemawashi"	Common Superior	Total
Fixed-Size Procedure	15	51	16	82
Sequential Procedure	3	23	25	51
Total	18	74	41	133

Chi square = 14.11

Cramer's coefficient of contingency = 0.326

Significance = 0.0009

Table 3. Cross-tabulation by decision procedures and conflict resolution modes.

Department	Cramer's Coefficient of Contingency	Chi Square	Significance	Number of Effective Samples
Production Department	0.201	2.55	n.s.	63
Sales Department	0.388	10.67	p=0.0305	71
Research Department	0.437	11.27	p=0.0237	59
Corporate Division	0.538	19.10	p=0.0008	66

Table 4. Summary of cross-tabulations by decision procedures (the fixed-size and the sequential procedure) and organizing modes (creation of slack resources, creation of self-contained tasks, investment in vertical information systems, and creation of the lateral relations) for each department.

Organizing Modes Having Significant

Relevance with Decision Procedures*

Department	Sequential Procedure	Fixed-Size Procedure
Production Department		
Sales Department	(a) (b)	(d)
Research Department	(a)	(d)
Corporate Division	(a) (b)	(c)

* (a) Creation of slack resources   ⎱ To reduce the need for

  (b) Creation of self-contained tasks   ⎰ information processing

  (c) Investment in vertical information systems ⎱ To increase information

  (d) Creation of lateral relations   ⎰ processing capacity

Table 5. Organizing modes having significant relevance with
decision procedures in Table 4.

	Phi Coefficient	Chi Square	Significance	Number of Effective Samples
Total	0.131	4.07	p=0.0436	236
Manufacturing Industry	0.154	3.58	p=0.0585	150
Non-Manufacturing Industry	0.050	0.22	n.s.	86

Table 6. Summary of cross-tabulations by decision procedures (the fixed-size and the sequential procedure) and computer systems (on-line system and not on-line system).

	Phi Coefficient	Chi Square	Significance	Number of Effective Samples
Total	0.222	12.02	p=0.0025	245
Manufacturing Industry	0.183	5.23	p=0.0222	156
Non-Manufacturing Industry	0.268	6.40	p=0.0407	89
High-Performer	0.286	10.61	p=0.0050	130
Low-Performer	0.170	2.92	n.s.	101

Table 7. Summary of cross-tabulations by decision procedures (the fixed-size and the sequential procedure) and listed securities exchanges (listed on the First Section of Tokyo Securities Exchange and on the other securities exchanges).

Biographical Notes

NOBUO TAKAHASHI (MBA, University of Tsukuba) is a Ph.D. student in the Doctoral Program in Socio-Economic Planning at the University of Tsukuba. His research interests are application of statistical decision theory to organization design and organizational behavior.

SATORU TAKAYANAGI (MBA, University of Tokyo) is a Proffessor in the Institute of Socio-Economic Planning at the University of Tsukuba. His research interests include decision making and communication in the organizations.