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THE EXPERT ANALYSIS PROCEDURE FOR DEFINING THE SCIENTIFIC
STRUCTURE OF THE STATE-OF-THE-ART SURVEY PUBLICATIONS

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Background

To facilitate widespread international exchange of experience with the applications of systems analysis, IIASA has established a Survey Project to produce publications whose purpose is to systematize and generalize the experience gained in developing and applying systems analysis as a normative methodological base for solving large-scale management problems.

The publications--a Series and a Handbook--are to be addressed to a wide audience of scientists and engineers, instructors, graduate and undergraduate students, practitioners, and specialists interested in the problems of applying modern scientific methods of management.

This activity is the first such undertaking in the field of systems analysis. Consequently, a number of difficulties arise in preparing the scientific structure of the publications. One way to tackle the problem is to employ expert analysis methods; these methods draw upon the experience and knowledge of specialists in the field of systems analysis and make possible the preparation of a comprehensive and representative structure for the publications that includes both current practice and established scientific findings.

Expert Analysis Methods

Expert analysis methods are defined as a set of techniques and procedures used in conducting a poll of highly skilled specialists by which reliable group conclusions can be obtained on any subject without face-to-face discussion. The specialists state their opinions and consider the responses and arguments of their colleagues.

The principal features of the expert analysis methods are

- o Anonymity of experts' responses through the use of specially designed questionnaires. These questionnaires prevent the negative influence of such psychological factors as a tendency to agree

^{*}Text of a presentation by Dr. A. P. Iastrebov at IIASA on 24 October 1974.

with the majority (the so-called "bandwagon" effect) or an unwillingness to change publicly the judgment expressed previously.

- o Organization of experts' responses by means of an iterative procedure.
- o Use of mathematical methods to determine agreement among the experts.

One of the most well-known expert analysis methods is the "Delphi" method. Most modern expert analysis methods make use of this method: the expert responds to the questionnaire individually, then receives the generalized opinions of the other experts, and answers the questionnaire again. The process can be repeated several times until independent and comprehensive experts' opinions are obtained.

Although the main advantage of the "Delphi" method is that it precludes the negative influence of the psychological factors mentioned previously, considerable time is required to conduct the poll, and the method excludes in advance any opportunity of collecting data by means of face-to-face discussion. This lack of discussion is a distinct disadvantage; the experience of applying such methods as the "brain storming" procedure has shown that sometimes face-to-face discussion can result in obtaining valuable information if special rules of organizing the discussion are followed and if the group consists of authoritative and equally competent experts. One additional shortcoming of the "Delphi" method is that it is oriented toward identification of averaged group opinion rather than toward different points of view of specialists participating in the poll.

Advantages of the Expert Analysis Procedure

The expert analysis procedure overcomes these shortcomings of the Delphi approach and can be used in the Survey Project to

- o Conduct a poll of a broad range of specialists from different countries working in various fields of systems analysis, with the "Delphi" approach as a preliminary stage.
- o Identify authoritative systems analysis specialists whose opinions most fully express the interests of the audience.
- o Process the results of a questionnaire formally and analyze reasons for possible divergence of opinions among different specialists' groups.
- o Prepare a creative, professional atmosphere in which the most authoritative specialists can meet with the aim of analyzing questionnaire results and outlining editorial policies concerning publications on the state-of-the-art of systems analysis.

General Stages in the Expert Analysis Procedure

As shown in Figure 1, the structure and content for the state-of-the-art publications is prepared in several stages. The first stage is a statement of the research problem. The goals are set and the initial data (the first draft of structure and content) prepared. Experts are then nominated for participation and questionnaires composed for polling their opinions. The experts analyze the questionnaire and respond in writing without any contact with other experts. The completed questionnaires are then returned for processing and analysis. At this stage,

- o A generalized group opinion, which is to the largest degree in agreement with individual judgments, is determined for each item on the questionnaire.
- o The statistical significance of the responses is determined.
- o The entire body of experts is divided into groups according to opinions, and within each group, experts are identified whose judgment is most representative of the group ("typical experts").

The data obtained at this stage are discussed and generalized. There may be meetings between specialists responsible for preparation of the publications and "typical experts," in order to edit proposals on the structure, define the arguments behind the proposals made by different groups, and identify possible authors and scientific editors of the publications.

At the end of these meetings a second questionnaire is developed, and the experts are asked to respond again. The data received are then processed and used directly in making decisions regarding structure and a body of contributors and scientific editors.

The results of the second poll should give a sufficiently comprehensive idea of the opinions of a wide range of scientists regarding the structure of the publications. If necessary, one or more additional rounds of discussions can be conducted, the results updated, and subsequent questioning of the experts carried out.

Details of the Various Stages

Problem Statement

Specialists responsible for preparation of the publications write a statement describing the goals of the publications and possible versions of the structure.

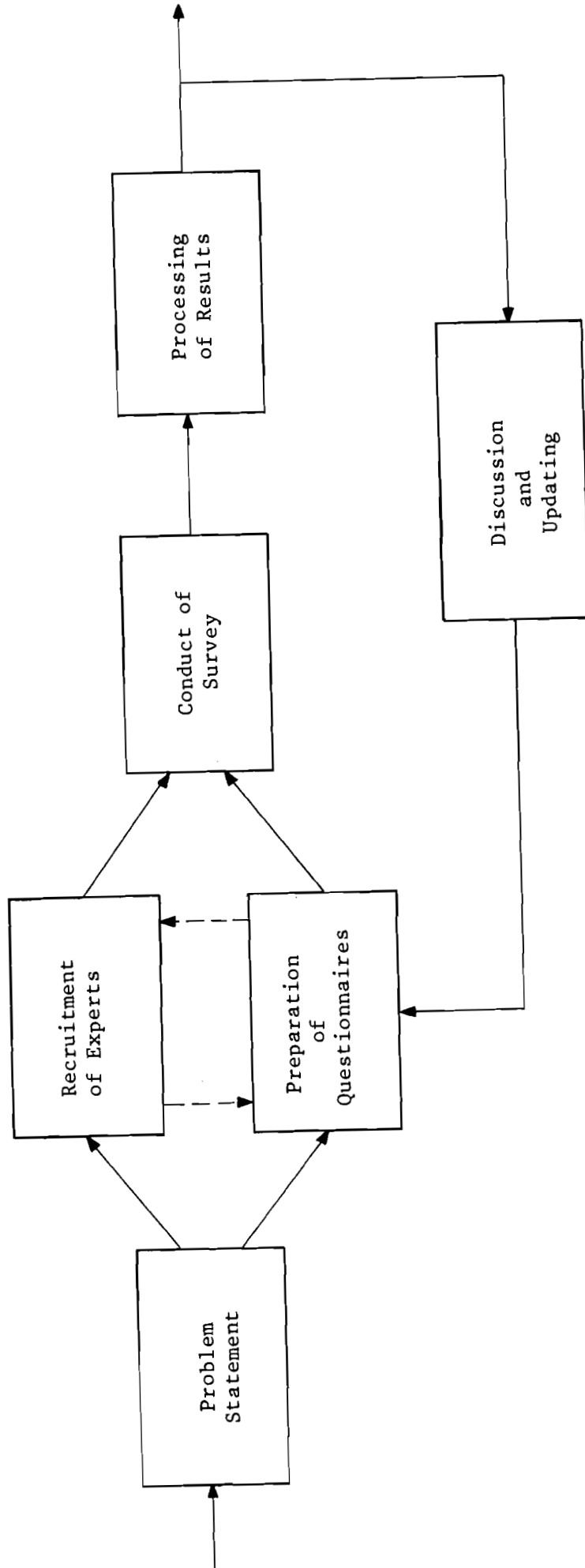


Figure 1--General stages in th expert analysis procedure

Recruitment of Experts

The basic criteria for nomination and recruitment of experts may be well-established indicators such as scientific degree, position(s) held, number of published papers (especially on systems analysis), etc. Special consideration should be given to the desire of experts to participate and to proposals submitted by authorities in systems analysis and by the NMOs.

Preparation of Questionnaires

The questionnaire is the basic document for the poll. The package distributed to the expert will include

- o A description of the basic goals of the proposed publication.
- o Versions of the publication structure.
- o The questionnaire.
- o Instructions for filling in the questionnaire.
- o Definition of the contents of parts and sections.

Because of the comprehensive framework of systems analysis, it is necessary to establish a hierarchical structure for the publications and to prepare different kinds of questionnaires for different levels of the structure hierarchy.

An example of the first level of structure in the questionnaire is shown in Figure 2.

This questionnaire includes topics ("General Parts") that might be used as subjects for separate volumes or issues.

The expert is asked to analyze the proposed topics and

- o If necessary, update or add to the list of topics by using the blank spaces in column 2.
- o State an opinion about including a particular part in the structure by entering a cross (X) in either column 3 or 4.
- o Estimate the importance of the included parts by entering a cross (X) in columns 5, 6, or 7.

Column 8 can be used for additional notes or comments.

An example of the second level of structure in the questionnaire is shown in Figure 3. This questionnaire is similar to the previous one except for the following columns:

LEVEL I

Version A

A = Very important
 B = Important
 C = Not so important

No.	General Parts	To Be Included		Importance			Notes
		Yes	No	A	B	C	
1	2	3	4	5	6	7	8
1	Historical Background and Conceptual Foundations of Systems Analysis	X			X		
2	Interdisciplinary Foundations of Systems Analysis						
3	Theory and Methodology of Systems Analysis						
4	Fields of Application of Systems Analysis						
5	Reference Materials						

Figure 2--Example of the first level of structure

LEVEL II

Version A

- A = Very important
- B = Important
- C = Not very important
- D = No knowledge

No.	Parts	No.	Sections	To Be Included		To Which Part Does It Belong?	Importance				Notes
				Yes	No		A	B	C	D	
1	2	3	4	5	6	7	8	9	10	11	12
1	Historical Background and Conceptual Foundations	1.1	History of Systems Analysis	X		1		X			
		1.2	Philosophical Problems of Systems Analysis								
2	Interdisciplinary Foundations of Systems Analysis	2.1	Operations Research	X		3	X				
		2.2									
		2.3									
		2.4									
		2.5	Management Theory								
		2.6									
		2.7									

Figure 3--Example of the second level of structure

- o Column 4 lists the second-level topics (Sections).
- o Column 7 is used by the expert to attribute the second-level topics to the first-level topics.

Conduct of the Survey

Each expert responds to the questionnaire individually. Wherever necessary, the organizers of the questionnaire can interview the experts.

Processing the Questionnaires

Processing the questionnaires includes

- o Formulation of statements summarizing generalized group opinion about the importance of each topic.
- o Calculation of concordance among opinions by means of the following formula:

$$V = \frac{s}{m^2 n (s-1)} \sum_{i=j} \sum_{j=1} \left\{ x_{ij} - \frac{m}{s} \right\}^2,$$

where x_{ij} = the number of experts who assigned j -th importance to the i -th topic;

s = the number of importance grades;

m = the number of experts participating;

n = the number of topics to be estimated; and

V = a range from 0 to 1 ($V = 0$ implies that there is no agreement at all; $V = 1$, complete unity of experts' views).

- o Estimate of the statistical significance of the results by testing the statistical hypothesis that the experts' views coincide randomly against the alternative that there is coordinated agreement among the experts. (Chi-squared distribution is used.)
- o Delineation of groups of experts according to their views, based on combinatorial algorithms of coupling matrix diagonalization; further contextual analysis of individual judgments identifies "typical experts" in a group whose opinions are the best representation of the views of experts in that group. As a result, there is a reduction in the number of experts who participate in discussion, and the task of updating results is minimized.

Discussion and Updating

The organizers of the survey and the "typical experts" may convene for a discussion, and certain procedures may be adopted that help identify the arguments behind the judgments of the groups of experts; at these discussions, authors and scientific editors may be recommended for the state-of-the-art publications.

Use of Results

In sum, the expert analysis procedure will generate results that make it possible to

- o Update and correct the first draft of the publication structure and identify and aggregate topics.
- o Estimate the importance* of including individual topics in the publications.
- o Recommend authors and scientific editors.

Undoubtedly this procedure is not the only way to collect data for preparing the structure of the publications. Other techniques such as meetings, conferences, seminars, and informal contacts may be useful complementary means to gather additional data.

* Depending on the definition of "importance," the data obtained through this procedure can be used to make decisions on the structure, size of articles, placement of material (in either the Handbook or the Series), and the priority and periodicity of publications on various problems in the methodology of systems analysis.