

THE
RISK RANKING
TECHNIQUE
IN
DECISION MAKING

JOHN C. CHICKEN
and
MICHAEL R. HAYNS

PERGAMON PRESS

The Risk Ranking Technique

in

Decision Making

JOHN C. CHICKEN

*J. C. Consultancy Ltd, Godalming, Surrey, UK, and
John C. Chicken Consultancy GmbH, Langenargen, FRG*

and

MICHAEL R. HAYNS

*United Kingdom Atomic Energy Authority,
Harwell Laboratory, Didcot, Oxon, UK*

PERGAMON PRESS

**OXFORD · NEW YORK · BEIJING · FRANKFURT
SAO PAULO · SYDNEY · TOKYO · TORONTO**

U.K.	Pergamon Press plc, Headington Hill Hall, Oxford OX3 0BW, England
U.S.A.	Pergamon Press, Inc., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A.
PEOPLE'S REPUBLIC OF CHINA	Pergamon Press, Room 4037, Qianmen Hotel, Beijing, People's Republic of China
FEDERAL REPUBLIC OF GERMANY	Pergamon Press GmbH, Hammerweg 6, D-6242 Kronberg, Federal Republic of Germany
BRAZIL	Pergamon Editora Ltda, Rua Eça de Queiros, 346, CEP 04011, Paraiso, São Paulo, Brazil
AUSTRALIA	Pergamon Press Australia Pty Ltd., P.O. Box 544, Potts Point, N.S.W. 2011, Australia
JAPAN	Pergamon Press, 5th Floor, Matsuoka Central Building, 1-7-1 Nishishinjuku, Shinjuku-ku, Tokyo 160, Japan
CANADA	Pergamon Press Canada Ltd., Suite No. 271, 253 College Street, Toronto, Ontario, Canada M5T 1R5

Copyright © 1989 J. C. Chicken and M. R. Hayns

All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means: electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the publisher.

First edition 1989

Library of Congress Cataloging in Publication Data

Chicken, John C.

The risk ranking technique in decision making/
John C. Chicken and Michael R. Hayns.—1st ed.

p. cm.

Bibliography: p.

Includes index.

1. Decision-making. 2. Risk assessment.

I. Hayns, Michael R. II. Title.

T57.95.C47 1989 658.4'03—dc19 89-31105

British Library Cataloguing in Publication Data

Chicken, John C. (John Charles) 1926—

The risk ranking technique in decision making.

1. Risk management

I. Title II. Hayns, Michael R.

658.4'03

ISBN 0-08-037212-0

In order to make this volume available as economically and as rapidly as possible the author's typescript has been reproduced in its original form. This method unfortunately has its typographical limitations but it is hoped that they in no way distract the reader.

Printed in Great Britain by BPCC Wheatons Ltd, Exeter

Preface

There have been many excellent proposals for aids to decision making. Most of these proposals tend to deal with only one group of the factors that have to be considered in assessing the acceptability of major high technology projects. In this book we develop a comprehensive approach, known as the Ranking Technique, for the assessment of decision options. The aim being to provide a way of presenting a decision maker with a consistent way of making a comprehensive assessment of all the factors associated with complex decisions. The Ranking Technique we describe, while being based on a thorough and detailed analysis of all the issues involved, presents the results of the analysis in a simple transparent and justifiable way that should be understandable by the lay public not versed in the complexities of the issues involved. In our presentation of the Ranking Technique we attempt to justify the logical basis of the Technique and to describe how it can be applied. Although we illustrate the use of the Ranking Technique by post hoc application to only four major decisions that caused controversy and one fuel resource evaluation we stress the Technique is applicable to all decision making situations. It is our contention that the Technique provides a logical and justifiable approach to the assessment of decision options, which should be useful both to those directly involved in the decision making process and to students of decision making.

The study describes how technical, economic and socio-political factors can be evaluated and their significance integrated to give a comprehensive assessment of the decision options. Appendices to the study describe: the essential features of the Ranking Technique, definition of the terms used in the study, a review of some technical acceptability criteria that have been used and an outline of the essential steps in reactor licensing procedure.

We hope all that read this study will find that it shows ways in which the decision making processes they are associated with can be improved in a rational and logical way.

JCC
MRH

Contents

	Preface	vii
	List of Figures	viii
	List of Tables	ix
Chapter 1	INTRODUCTION	1
Chapter 2	THE PROBLEMS OF DECISION MAKING	4
Chapter 3	THE RELEVANCE OF DECISION ANALYSIS TECHNIQUES CURRENTLY AVAILABLE	12
Chapter 4	THE NATURE OF THE RANKING TECHNIQUE	18
Chapter 5	EVALUATION OF TECHNICAL FACTORS FOR RANKING	23
	Nature of Technical Factors	23
	Evaluation of Technical Factors	25
	Criteria for Ranking Technical Factors	29
Chapter 6	EVALUATION OF ECONOMIC FACTORS FOR RANKING	32
	Economic Arguments	32
	Evaluation of the Economic Factors	34
	Criteria for Ranking Economic Factors	36
Chapter 7	EVALUATION OF SOCIO-POLITICAL FACTORS FOR RANKING	41
	Nature of Socio-political Information	41
	How the Information May Be Obtained	43
	Recent Surveys	43
	Criteria for Ranking Socio-political Factors	52
Chapter 8	ASSESSMENT OF THE POTENTIAL EFFICACY OF THE RANKING TECHNIQUE	55
	Canvey Island	57
	Moss Morran	58
	Rijnmond	59
	Channel Tunnel	62
	Energy Options	64
Chapter 9	THE BASIS FOR ALTERNATIVES TO THE RANKING TECHNIQUE IN THE DECISION MAKING PROCESS	72
	Qualitatively Based Alternatives	73
	Quantitatively Based Alternatives	75
	Conclusions	77

Chapter 10	GUIDELINES FOR THE APPLICATION OF THE RANKING TECHNIQUE	79
	Use of the Ranking Technique	81
	Who Should Use the Ranking Technique?	84
	Input Required	87
	Output Expected	88
	Overall View of Ranking	90
Chapter 11	CONCLUSIONS	94
	References	97
	Appendixes	
	Appendix 1: Summary of the Essential Features of the Risk Ranking Technique	102
	Appendix 2: Definitions	108
	Appendix 3: Range of Technical Acceptability Criteria	111
	Appendix 4: A Summary of the Policy Statement of US Nuclear Regulatory Commission on Safety Goals	115
	Appendix 5: Steps in Reactor Licensing Procedure	116
	Bibliography	117
	Index	120

List of Figures

FIGURE 1	Elements of the real system set relevant to the decision making process set	6
FIGURE 2	Decision making continuum	7
FIGURE 3	Model of a technical factor	24
FIGURE 4	Steps in the opinion survey process	45
FIGURE 5	Percentage of sample concerned about various risks	46
FIGURE 6	Ranking decisions	80
FIGURE 7	Matrix display of Ranking results	89
FIGURE 8	Ranking matrix limits	91
FIGURE 9	Ranking Technique application flowsheet	92
FIGURES IN APPENDICES		
FIGURE 1.1	Flowsheet for application of Ranking Technique	104
FIGURE 1.2	Ranking description of uncertainty	105
FIGURE 3.1	Quantitative and Qualitative statement of Joint Airworthiness requirement for acceptability	112

List of Tables

TABLE 1	Summary of changes possible with time in the decision making environment	5
TABLE 2	The nature of simple decisions	9
TABLE 3	Illustrations of the general nature of comprehensive decisions	10
TABLE 4	Composition of the main groups of ranking factors	19
TABLE 5	Summary of precautions to reduce errors in data used	22
TABLE 6	Summary of risk acceptability criteria in several countries	27
TABLE 7	Proposed technical risk acceptability criteria	30
TABLE 8	Sample of CSX values	37
TABLE 9	Possible basis for Ranking economic factors	38
TABLE 10	Possible relationship between economic factors Ranking score	40
TABLE 11	Techniques for assessing views on acceptability	44
TABLE 12	Concern about six hazards	47
TABLE 13	Views on the advantages of developing nuclear power	50
TABLE 14	Analysis of answers in 1982 and 1984 to the question: which three installations in your opinion create the greatest risk to people living nearby	51
TABLE 15	Summary of changes between 1982 and 1984 in views on nuclear risks	51
TABLE 16	Shift in opinions about nuclear power between 1982 and 1984	53
TABLE 17	Possible relationship between socio-political factors and Ranking score	54
TABLE 18	Ranking of Canvey Island risks	58

List of Tables

TABLE 19	Ranking justified for the Moss Morran proposal	59
TABLE 20	Comparison of the official Maasvlakte and Eemshaven risk data	61
TABLE 21	Ranking justified for the Maasvlakte site	61
TABLE 22	Ranking justified for the Eemshaven site	62
TABLE 23	Summary of the main Channel Crossing technical factors of interest	63
TABLE 24	Summary of the main Channel Crossing economic factors of interest	64
TABLE 25	Summary of Channel Crossing socio-political factors	65
TABLE 26	Channel Crossing technical factor Rank score of proposals	66
TABLE 27	Channel Crossing economic factor Rank score of proposals	67
TABLE 28	Channel Crossing socio-political factor Rank score of proposals	67
TABLE 29	Overall Ranking of the acceptability of Channel Crossing proposals	68
TABLE 30	Public safety considerations in fuel options	69
TABLE 31	Public safety considerations in quantitative terms	69
TABLE 32	National and International concerns about public safety	70
TABLE 33	Preferred solutions and priorities from EEC public opinion survey	71
TABLE 34	Overall Ranking of the energy options	71
TABLE 35	Procedure for analysis of qualitative evidence	74
TABLE 36	Classification of decision makers for simple decisions	85
TABLE 37	Classification of decision makers for complex decisions	86

List of Tables

xi

TABLES IN APPENDICES

TABLE 1.1	Construction of Risk Rank	102
TABLE 1.2	Definition of criteria that have been used for scoring technical acceptability	103
TABLE 1.3	Possible relationship between economic factors and the Ranking score	106
TABLE 1.4	Possible relationship between socio- political factors and the Ranking score	107

Chapter 1

Introduction

Quotations from "The Official Rules",*
Ashley-Perry's fifth statistical axiom:
"The product of an arithmetical computation
is the answer to an equation: it is not the
solution to a problem."
Thurber's conclusion: "There is no safety in
numbers, or in anything else."

Starting from the challenge of the two quotations above this study examines how in reality complex decisions can be made more effectively with the assistance of objective and logical disciplines. The type of decision particularly considered is a final decision about whether or not a project goes ahead. It is assumed the decision maker involved will have overall responsibility for making the decision in a clearly defensible way on the best information available. It is not assumed that the decision maker is an expert in every field involved but it is assumed that he has access to any additional expert opinion that may be required. More specifically the aim of the study is to critically examine the capability of the Risk Ranking Technique for dealing effectively with a variety of complex decision making situations, including decisions related to controversial projects and projects that involve assessing the acceptability of major risks, when every associated factor from technical characteristics to public opinion has to be taken into account. The incentive for developing the Risk Ranking Technique was the need to provide decision makers with a method for making comprehensive assessments in a way that deals consistently with the matrix of factors involved. In developing the technique the aim was to provide decision makers whether at the political or industrial level with a transparent and defensible way of arriving at decisions. Even for smaller decisions in which only a single range of factors need be considered the technique provides a logical structure to the assessment of the options involved. The basis of the Ranking Technique is the comprehensive assessment of all the associated technical, economic and socio-political factors. The Technique, which is described at length in references 1 and 2 and is summarized in Appendix 1, consists of assessing the acceptability of each of the factors involved and scoring the results of the assessment on a scale of 0-4. The higher the score the lower the acceptability, the overall Ranking of acceptability being determined by integrating the scores of the individual factors. The Ranking that an activity is given will provide the decision maker, whether at the regulatory level or the project management level with a yardstick to judge in a consistent way how acceptable the activity is.

By the nature of the circumstances of decision making, decisions often have to be made under conditions when the data about the subject of the decision are sparse and uncertain. Such circumstances are not

*Paul Dickson's "Official Rules", published Arrow Books, London 1981.

2 *The Risk Ranking Technique in Decision Making*

unusual in decision making in business or in scientific and technological developments. Unless solutions are found to these problems developments that could be useful to society may be inhibited. To overcome these inherently complex problems several techniques have been proposed. Part of this study is devoted to evaluating the techniques currently available and comparing their efficacy with the Risk Ranking Technique.

Among the many general texts on decision making, Koutsogiannis' "Non Price Decisions"⁽³⁾ and Matthew Miles and Michael Huberman's "Qualitative Data Analysis" are particularly useful.⁽⁴⁾ Very practical and direct guides to the subject are given by: Myra Chapman in her "Decision Analysis",⁽⁵⁾ Maurice Preston's "Statistical Decision Theory",⁽⁶⁾ and Gordon Hilton's "Intermediate Politometrics".⁽⁷⁾ The methods they describe are of considerable help in arranging and evaluating complex evidence in a logical way that assists the decision maker to reach a verdict. David Pearce's "Decision Making for Energy Futures", which was based on a study of the Windscale Inquiry for the Social Science Research Council, shows clearly the complex range of factors that have to be considered in government policy decisions.⁽⁸⁾

Like any analytical techniques decision analysis techniques have their limits and should not be used uncritically. It is therefore vital that the suitability of a technique for assessing a particular problem is determined before any value is given to its results. Determination of the suitability of a method includes assessing whether or not relevant data exists and if data exists how exactly they fit the case being examined. In the evaluation of a new or novel process data that precisely fits the specific case is unlikely to be available and any evaluation has to be based on synthetic data. Synthesizing data is a process that by its very nature involves uncertainty. This does not mean a novel process will fail, it simply means it is not known with absolute certainty how successful it will be. The Space Programme illustrates how success can be achieved and the cost that may be involved when there is little relevant data.

The analyst, the techniques used and the stage in a project's life at which the assessment is made all influence the decision making. The changes in the relevance of the results of an assessment that take place with the passage of time can be quite dramatic. Unless the decision is made and implemented in the same instant the need for the decision may change and the relative significance of the associated factors may change.

Judging the efficacy of a decision making process is not simple. One method is to assess how acceptable the decisions proposed are to those affected by them, another method is to assess how successful past decisions made on the basis of a particular decision making process have been. Judging success has, like so many aspects of decision making, many qualitative aspects. But techniques exist to help the making of such judgements. Central to any judgement of the efficacy of decision making techniques is determination of the decision making environment. In this study the Ranking Technique is tested on five major proposals, which have given rise to a certain amount of public

concern. These tests show how effective the Technique can be in predicting the most acceptable decision.

Although the capability of the Ranking Technique is demonstrated on five quite different proposals the examples do not define the limits of the Technique or the most likely users. The Technique is intended mainly for assessing complex decisions where the way account is taken of the whole matrix of technical, economic and socio-political factors has to be clear and defensible. Even though the Technique is designed to deal comprehensively with the whole matrix of factors involved in complex decisions it can be used when the decision is related to just one factor. The decision makers to whom the Technique is likely to be of most interest will be at either a senior political or a senior industrial level and with responsibility for justifying and defending project decisions in terms of the technical content, financial implications or socio-political acceptability.

In the following the analysis of the capability of Ranking Technique as an aid to complex decision making is built up in ten steps. The steps are:

- 1) The problems of decision making particularly when the decision involves the acceptability of major risks.
- 2) The relevance of decision analysis techniques currently available.
- 3) The nature of the Ranking Technique.
- 4) Evaluation of technical factors for Ranking.
- 5) Evaluation of economic factors for Ranking.
- 6) Evaluation of socio-political factors for Ranking.
- 7) Assessment of the efficacy of the Ranking Technique in five cases.
- 8) The basis for alternatives to the Ranking Technique in decision making.
- 9) Guidelines for the use of the Ranking Technique.
- 10) The overall conclusions suggested and future developments.

Some of the terms used in the study may, in general usage, have several meanings, so to prevent any misunderstanding the meaning attributed to them in this study are specified in Appendix 2.

Chapter 2

The Problems of Decision Making

Decision making takes many forms but the type of decisions that are the main concern of this study are those involving the evaluation of many complex factors, which are difficult to evaluate comprehensively in a uniform and consistent way. It is characteristic of such decisions that they have to be made in a transparently justifiable way and not on the basis of some capricious whim. The importance of transparency being that it allows it to be seen, by all interested parties, that all the relevant technical, economic and moral issues have been considered. Such decisions may arise in companies or at national or international government level. To clarify the types of decision making problems considered first the main types of decision are described and categorised, then the nature of the problems associated with each category of decision are assessed. From this assessment conclusions are drawn about the way the Ranking Technique is most likely to help each type of decision making situation.

Decision making can be described in deceptively simple terms, such as "agreeing the course of action required". Such simple definitions miss many of the important nuances associated with the various parts of the decision making process. For an examination of the various types of decision making process to lay any claim to being thorough it must identify not only the nature of the demands for a decision, the goal of a decision and the consequences of a decision, but also the environment the decision making process has to operate in. The whole environment is often conditioned by the fact that there is a need to be able to show how a particular decision was reached. This need may arise from: those directly involved in decision making, from the people affected by the decision, the general public and out of consideration for those following who must operate future decision making activities.

The first step towards identifying the various types of decision is to identify the essential elements of the environment that may surround any decision making process. In reference 9 a model of the environment of policy making was proposed and that model is used as the foundation for the model of the environment of the decision making process used in this study, as the processes are closely related. The decision making environment is seen as just one part of the universal environment set which includes all real and transcendental systems sets. Transcendental systems sets are those sets outside present knowledge, so only real systems sets are relevant to this discussion. Real system sets include: designed physical system sets, human activity system sets, designed abstract system sets and social and cultural systems sets. Designed physical system sets embrace all the inanimate products of man's activity such as machines and factories. Human activity systems are defined as all systems that exist as a result of human endeavour like cities, political systems and computer systems. Designed abstract system sets represent the knowledge man has developed. Social and cultural system sets in some way overlap

the human activity systems sets and the designed abstract systems sets. The elements of the real systems set most relevant to the decision making process are shown diagrammatically in a simplified form in Figure 1. One variable the figure does not show is time. The influence of time is ubiquitous it influences impartially both the explained and the explanatory variables in the argument. Time has to be allowed for in the assessment of each variable.

Each of the elements identified represents a complete group of relevant factors so that taken together the elements define all the factors that make up the environment surrounding the decision making process. The significance of any factor may vary with time. For example, in a major project the importance of financial resources is different at the conceptual stage when the demand for funding is low compared with the construction stage when the demand for funding is real and can be very significant even in national terms. Table 1 summarizes the ways the environment surrounding a decision may change with time. Attention is particularly drawn to the fact that with the passage of time the need for a decision may either increase or decrease.

TABLE 1 SUMMARY OF CHANGES POSSIBLE WITH TIME IN THE
DECISION MAKING ENVIRONMENT

DECISION VARIABLE	CHANGES THAT MAY OCCUR WITH THE PASSAGE OF TIME
KNOWLEDGE	Improved knowledge may show action no longer required or must be modified
RESOURCE REQUIREMENT	Demand for resources in terms of material, finance or manpower may be different to that originally predicted.
REQUIREMENT FOR DECISION	Demand for decision and action may increase or decrease

The need for a decision can, with some justification, be described as being generated by various elements in the environment surrounding the decision making process. For this study the decision making process is defined as: the interaction between elements within the decision making set that result in determination of how demands that arise can be most acceptably satisfied with the resources available. This concept of decision making being an interaction between the related elements of a set is illustrated in Figure 2, which shows the decision making process being a continuum lasting from the emergence of the demand to the satisfaction of the demand. During the time of the decision making process the significance of the various variables involved may change. In a decision involving a scientific or technological development the changes that have to be allowed for in knowledge may be quite dramatic.

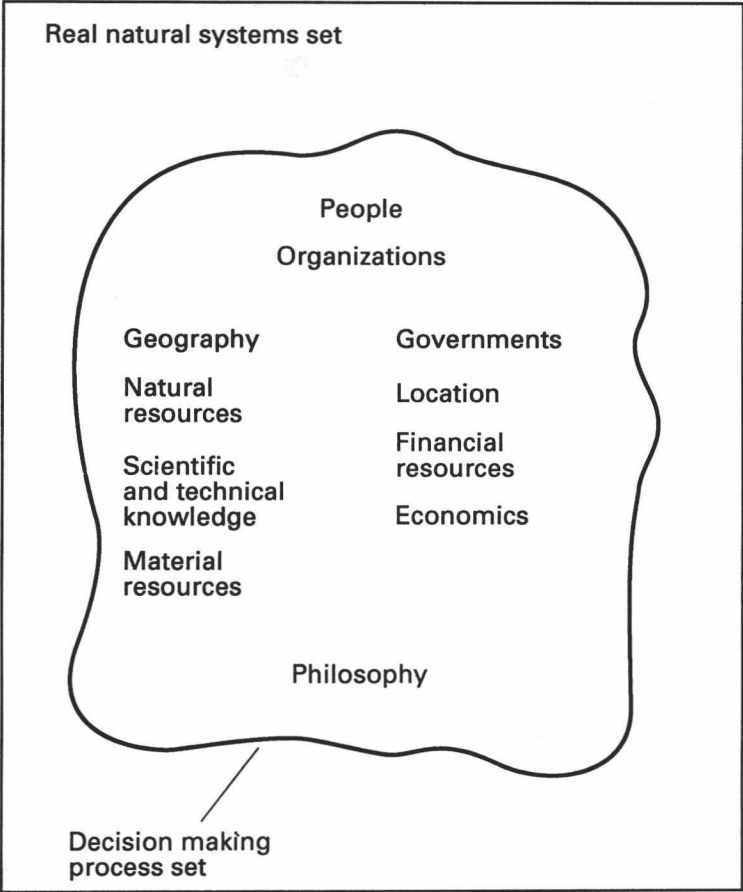


Fig 1 Elements of the real systems set relevant to the decision making process set

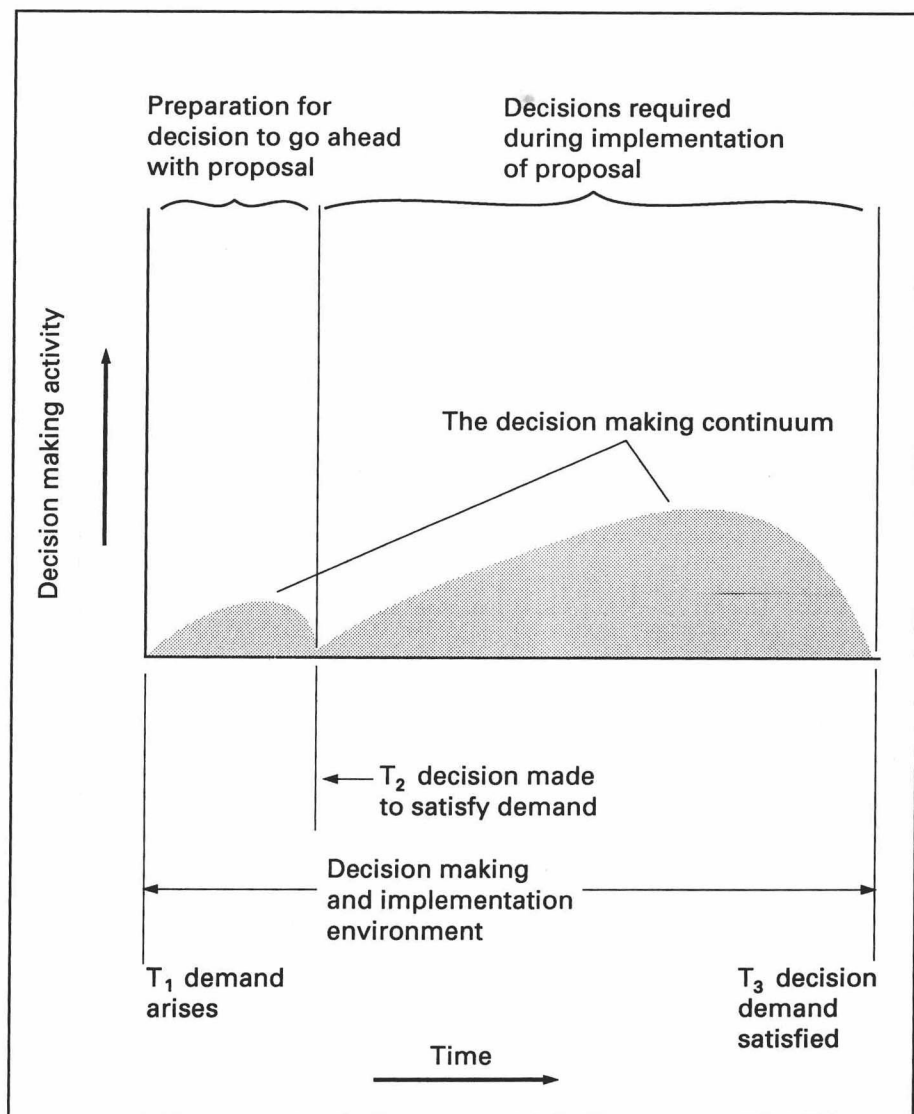


Fig 2 Decision making continuum