



Some pages of this thesis may have been removed for copyright restrictions.

If you have discovered material in Aston Research Explorer which is unlawful e.g. breaches copyright, (either yours or that of a third party) or any other law, including but not limited to those relating to patent, trademark, confidentiality, data protection, obscenity, defamation, libel, then please read our [Takedown policy](#) and contact the service immediately (openaccess@aston.ac.uk)

A SYSTEMS APPROACH TO STRATEGIC
MANPOWER PLANNING FOR TECHNOLOGICAL
DEVELOPMENT UNDER CONDITIONS OF
MANPOWER SCARCITY AND CENTRALISED
CONTROL

FALEH HASSAN MARHOON AL-KHAYAT

B.SC., M.SC., C.ENG., M.I.E.E.

DOCTOR OF PHILOSOPHY

ASTON UNIVERSITY

OCTOBER 1985

THE UNIVERSITY OF ASTON IN BIRMINGHAM

FALEH HASSAN MARHOON AL-KHAYAT

DOCTOR OF PHILOSOPHY

1985

SUMMARY

This thesis deals with the integration of the manpower criterion with the strategic decision making processes of technological projects in developing countries. This integration is to be achieved by ensuring the involvement of the actors, who have relevant roles and responsibilities along the whole life cycle of the project, in the strategic decision making phases of the project. The relevance of the actors is ascertained by the use of a responsibility index which relates their responsibility to the project's constituent stages.

In the context of a technological project in a typical centrally-planned developing environment, the actors are identified as Arbiters, Planners, Implementors and Operators and their roles, concerns and objectives are derived. In this context, the actors are usually government and non-government organisations. Hence, decision making will involve multiple agencies as well as multiple criteria.

A methodology covering the whole decision-making process, from options generation to options selection, and adopting Saaty's Analytical Hierarchy Process as an operational tool is proposed to deal with such multiple-criteria, multiple-agency decision situations. The methodology is intended to integrate the consideration of the relevant criteria, the prevailing environmental and policy factors, and the concerns and objectives of the relevant actors into a unifying decision-making process which strives to facilitate enlightened decision making and to enhance learning and interaction.

An extensive assessment of the methodology's feasibility, based on a specific technological project within the Iraqi oil industry is included, and indicates that the methodology should be both useful and implementable.

KEY WORDS: SYSTEMS, DECISION-MAKING, TECHNOLOGICAL PROJECTS, DEVELOPING COUNTRIES.

TO

AFRA, HASSAN & KHALID

ACKNOWLEDGEMENTS

I'm most grateful to my supervisor, Dr. John S. Edwards, for his guidance, help and patience without which this study would not have been possible.

I'm indebted to Mr. M. Luck and all the staff of the ORSA Group within the Information Management Division at the Aston Management Centre for the help they have given and the interest they have shown.

I'm most grateful to the Iraqi Ministry of Oil for granting me the study leave to undergo this research.

I'm indebted to all those Iraqi Managers, Engineers and Officials who have given me so much help and cooperation during the field work in Iraq.

My sincerest thanks to Mrs Gillian Suttle for her cheerfulness, speed, precision and accuracy when typing this thesis.

I'm profoundly indebted to my wife and my two sons who have given me so much joy and happiness during this study.

LIST OF CONTENTS

| | |
|--|------|
| SUMMARY | I |
| ACKNOWLEDGEMENTS | III |
| LIST OF CONTENTS | IV |
| LIST OF TABLES | VIII |
| LIST OF FIGURES | X |
| CHAPTER 1 INTRODUCTION | 1 |
| CHAPTER 2 THE DECISION MAKING CONTEXT OF DEVELOPMENT PROJECTS | |
| 2.1 INTRODUCTION | 7 |
| 2.2 DECISION MAKING APPROACHES | 8 |
| 2.2.1 The Rational Comprehensive Approach | 8 |
| 2.2.2 The Incrementalist Approach | 9 |
| 2.2.3 The Mixed Scanning Approach | 10 |
| 2.2.4 The Flexible Approaches | 12 |
| 2.2.5 Other Approaches | 15 |
| 2.3 PLANNING AND CONTROL | 17 |
| 2.4 THE MODE OF OWNERSHIP | 22 |
| 2.5 THE DECISION MAKING FRAMEWORK | 25 |
| CHAPTER 3 THE DECISION MAKING SYSTEM OF DEVELOPMENT PROJECTS | |
| 3.1 INTRODUCTION | 31 |
| 3.2 THE CHARACTERISTICS AND MANAGEMENT OF DEVELOPMENT PROJECTS | 31 |
| 3.2.1 Definitions | 31 |
| 3.2.2 The Size of Development Projects | 32 |
| 3.2.3 The Execution Modes of Development Projects | 33 |
| 3.2.4 The Management Forms of Development Projects | 34 |

| | | |
|------------------|--|-----|
| 3.3 | THE PRINCIPAL ELEMENTS OF DECISION MAKING | 37 |
| 3.3.1 | The Stages | 38 |
| 3.3.2 | The Actors | 45 |
| 3.4 | RESPONSIBILITIES, OBJECTIVES AND DECISION MAKING | 50 |
| | | |
| CHAPTER 4 | MULTIPLE CRITERIA DECISION MAKING - AN OVERVIEW | |
| 4.1 | INTRODUCTION | 59 |
| 4.2 | THE GENERAL DECISION SITUATION | 59 |
| 4.3 | THE METHODS OF MCDM | 63 |
| 4.3.1 | The Filtering Stream | 63 |
| 4.3.2 | The Reductionist Stream | 67 |
| 4.3.3 | The Programming Stream | 72 |
| 4.3.4 | The Pairwise-Comparison Stream | 74 |
| 4.3.5 | The Behavioural Stream | 82 |
| 4.4 | BASIC ISSUES IN MCDM | 86 |
| 4.4.1 | Decision Makers - Behaviour and Multiplicity | 87 |
| 4.4.2 | Alternatives - Generation and Richness | 92 |
| 4.4.3 | Criteria - Selection and Importance | 94 |
| 4.5 | PRINCIPLES FOR EFFECTIVE MCDM | 95 |
| | | |
| CHAPTER 5 | AN INTEGRATIVE METHODOLOGY | |
| 5.1 | INTRODUCTION | 98 |
| 5.2 | NOTATION AND STRUCTURING | 98 |
| 5.3 | DECISION MAKING METHODOLOGY | 99 |
| 5.3.1 | The Options Generation Phase | 101 |
| 5.3.2 | The Options Evaluation Phase | 105 |
| 5.3.3 | The Options Selection Phase | 110 |
| 5.4 | IMPLEMENTATION - ISSUES AND POSSIBILITIES | 114 |
| 5.4.1 | The Cultural Factors | 116 |
| 5.4.2 | The Organisational Factors | 116 |
| 5.4.3 | The Informational Factors | 117 |

| | | |
|------------------|--|-----|
| CHAPTER 6 | THE MANPOWER DIMENSION | |
| 6.1 | INTRODUCTION | 121 |
| 6.2 | MANPOWER IN PLANNING - AN OVERVIEW | 122 |
| 6.3 | MANPOWER IN DECISION MAKING | 128 |
| 6.4 | THE INTEGRATION OF MANPOWER | 133 |
| | 6.4.1 The Options Generation Phase | 133 |
| | 6.4.2 The Options Evaluation Phase | 135 |
| | 6.4.3 The Options Selection Phase | 137 |
| 6.5 | INFORMATIONAL ISSUES | 138 |
| 6.6 | STRATEGIC CONSIDERATIONS | 141 |
| CHAPTER 7 | CASE EXAMPLE - THE SOUTHERN-IRAQ LPG PROJECT, I: BACKGROUND AND ENVIRONMENT | |
| 7.1 | INTRODUCTION | 145 |
| 7.2 | THE FIELD INVESTIGATION | 146 |
| | 7.2.1 Aims and Objectives | 146 |
| | 7.2.2 Choice, Logistics and Methods | 147 |
| | 7.2.3 Limitations and Constraints | 153 |
| 7.3 | THE ENVIRONMENT OF THE LPG PROJECT | 153 |
| | 7.3.1 The National Scene | 153 |
| | 7.3.2 The Iraqi Oil Sector | 163 |
| | 7.3.3 The Manpower Constraint | 165 |
| 7.4 | THE LPG PROJECT | 183 |
| | 7.4.1 Background and General | 183 |
| | 7.4.2 Implementation - Roles and Responsibilities | 185 |
| | 7.4.3 Actors - Concerns and Objectives | 189 |
| CHAPTER 8 | CASE EXAMPLE - THE SOUTHERN IRAQ LPG PROJECT, II: TECHNOLOGICAL DECISION MAKING | |
| 8.1 | INTRODUCTION | 195 |
| 8.2 | THE PRIME MOVERS SELECTION CASE - BACKGROUND AND GENERAL | 195 |
| 8.3 | OPTIONS GENERATION | 197 |

| | | |
|---|--|-----|
| 8.4 | OPTIONS EVALUATION | 203 |
| 8.5 | OPTIONS SELECTION | 211 |
| 8.6 | THE IMPLEMENTATION OF THE METHODOLOGY | 212 |
| 8.6.1 | The Introduction of the Methodology | 213 |
| 8.6.2 | The Operationalisation of the Methodology | 219 |
| CHAPTER 9 DISCUSSION AND CONCLUSIONS | | |
| 9.1 | INTRODUCTION | 227 |
| 9.2 | SUMMARY | 227 |
| 9.3 | GENERAL DISCUSSION AND CONCLUSIONS | 228 |
| 9.3.1 | Principle Features of the Methodology | 229 |
| 9.3.2 | The Effectiveness of the Methodology | 232 |
| 9.3.3 | The Suitability of the Methodology for Developing Countries | 233 |
| 9.4 | SUGGESTIONS FOR FUTURE WORK | 235 |
| REFERENCES | | 237 |

LIST OF TABLES

| <u>TABLE NO.</u> | <u>DESCRIPTION</u> | <u>PAGE NO.</u> |
|------------------|---|-----------------|
| 3.1 | Modes of Project Execution in Developing Countries | 35 |
| 3.2 | Phases, Stages and Objectives of Industrial Development Projects | 39 |
| 3.3 | Suggested Project Stages for Technological Development Projects | 42 |
| 3.4 | Presumed Objectives of the Actors Involved in the Planning and Implementing Process of Technological Projects | 57 |
| 4.1 | Comparison Scale for the AHP Process | 78 |
| 7.1 | Organisations, Functions and Codes of the Interviewees | 152 |
| 7.2 | Growth Targets of the Third Five Year National Plan 1970-1974 | 156 |
| 7.3 | Allocation of National Development Plans 1970-1987 | 157 |
| 7.4 | Implementation Levels of the Iraqi Development Plans Over the Period 1970-1975 | 161 |
| 7.5 | Estimated Balance between Supply of Higher Education Graduates and Manpower Needs for the National Development Plan 1975-1980 | 168 |
| 7.6 | The Growth of the Iraqi Vocational Education Over the Period 1972-1982 | 171 |
| 7.7 | The Growth of the Iraqi Higher Education Over the Period 1972-1982 | 172 |
| 7.8 | The Distribution of the Iraqi Human Force according to Sex, Education Level and Economic Participation | 174 |
| 7.9 | The Distribution of the Iraqi Human Force according to Sex, Age Group and Economic Participation | 175 |
| 7.10 | The Distribution of the Graduates of the Oil Training Centre Over the Three Years Period 1979-1982 | 179 |
| 7.11 | The Number of Oil Centre Graduates who were working in the Oil Organisations in 1983 | 180 |

| | | |
|------|--|-----|
| 7.12 | Relationships between Increases in Gross Indicators and Increases in the Required Labour Force, as Envisaged by the SPO Five Year Plan 1979-1983 | 182 |
| 8.1 | Prime Movers Selection Case - Summary of Options Costs (Ranked in Ascending Order) | 204 |
| 8.2 | Rankings of Criteria by the Relevant Actors - The Prime Movers Selection Case | 209 |

LIST OF FIGURES

| <u>FIG NO.</u> | <u>DESCRIPTION</u> | <u>PAGE NO.</u> |
|----------------|--|-----------------|
| 3.1 | Integrated Project Planning and Management Cycle (I.P.P.M.C.): The Four Phases | 41 |
| 3.2 | Typical Clientele Influencing the Management of Large Development Projects | 47 |
| 3.3 | Scales of "Responsibility" Components (Suggested) | 52 |
| 3.4 | Detailed Stage Responsibility Matrix for the Principal Actors at the Stage of "Detailed Design" of a Typical Large Development Project | 53 |
| 3.5 | Overall Responsibility Matrix for the Principal Actors in a Typical Cycle of Large Technological Development Projects | 55 |
| 4.1 | Outline of Decision Matrix (D) | 62 |
| 4.2 | Schematic Representations of a Hierarchy and a Comparison Matrix | 77 |
| 5.1 | The Notation Hierarchy for Options Generation | 100 |
| 5.2 | The Mechanism of the Attenuation Process | 106 |
| 5.3 | The Options Generation Process | 107 |
| 5.4 | Graphical Representation of Actors' Ratings of Criteria | 113 |
| 5.5 | The Options Evaluation and Selection Phases | 115 |
| 6.1 | Manpower Profile for a Typical Technological Project | 131 |
| 6.2 | Integration of the Manpower Criterion in the Project's Decision Making Process | 139 |
| 7.1 | The Iraqi National Organisational Chart | 150 |
| 7.2 | Iraqi Ministry of Oil - Organisational Structure (1984) | 151 |
| 7.3 | Formulation of the Iraqi National Plans | 159 |
| 7.4 | Basic Outline of the Southern LPG Project | 186 |
| 7.5 | Schematic Relationships Between the Organisational Units Involved in the LPG Project | 190 |

| | | |
|-----|---|-----|
| 7.6 | Responsibility Matrix for the Principal Actors in the Implementation of the LPG Project | 191 |
| 8.1 | Equipment Configuration and System Layouts for the Compression Stations | 198 |
| 8.2 | Systematic Breakdown of the Selection of Compression Prime Movers Case | 199 |
| 8.3 | Sample Form for the Construction of Criteria Pairwise Comparison Matrix - LPG Case | 224 |

CHAPTER 1

INTRODUCTION

It is generally agreed (e.g. Cody et al, 1980) that the rate of national development in any country depends on the following factors:

- Endowment of human resources
- Endowment of natural resources
- Size and geographical location
- The international environment.

In their pursuit of social, economic and technological development, the developing countries have to face the major constraint of a severe shortage of skills and know-how - which represent an essential prerequisite for the execution of the development plans - among their population. Kenney et al (1972) stated that:

Content has been removed for copyright reasons

Ginzburg (1974) affirmed this when he stated that:



Aston University

Content has been removed for copyright reasons

Oil exporting countries are a special case of developing countries in that they enjoy, particularly since 1973, the relative availability of the necessary capital to finance their development plans. However a common feature in these countries, especially the Arab oil-producing ones, is the scarcity of the required skills among their populations; the pools of skills are in their infancy, small in size and very thinly spread. Also, the education systems are usually in their first phases of development and over-burdened with the provision of basic compulsory education and the fight against illiteracy. This is in addition to the fact that the population size in several of these countries is small and hence labour is scarce. Therefore, these countries are planning for development in a situation of manpower scarcity, and the manpower factor has replaced capital as the main

constraint to development, as it is the case in most other non-oil-producing developing countries.

National development in the Arab oil-producing countries is usually achieved via the execution of a series of development plans. These plans are mainly project orientated, and projects are regarded as the building blocks of these plans. The important projects usually entail huge commitments of resources (human as well as monetary) and require a substantial lead time to complete (e.g. power system development, refineries, oil field development). The technological dimension of these projects represents the backbone of the technological development of these countries and is an essential element in the development of skills among their populations.

In the formulation, selection, evaluation and scheduling of these projects, scant regard has usually been given to the impact of the manpower resource as compared with other criteria. This is due to the inherent characteristics of manpower as a resource, its delayed full impact in the project life cycle and the prevailing structure and dynamic nature of the decision making systems. This causes the neglect of important policy issues (e.g. acceptable ratios of national/non-national labour; required adjustments to the education and training systems), with possible adverse effects of delays, increased costs and unfavourable impacts on the socio-economic system.

Since projects are the manifestation of the development plans, then the planning, monitoring and control of their manpower requirements and supply, in type and quality, will represent the actual vehicle through which the country (the sector, the organisation) exercises actual control over its manpower resource. Hence, the consideration of the manpower resource has to be integrated within the decision making system of these projects.

Making decisions about large technological projects is never straightforward, because of their sheer complexity. But, when carried out in an

environment in which the major considerations are financial, the task is simplified by the dominance of quantifiable criteria. In developing countries on the other hand, the importance of such large technological projects to the country's overall development in social and technological, as well as economic, terms requires an evaluation process based on multiple criteria. Hence, the consideration of the manpower criterion has to be carried out within a multiple criteria decision making context. But, the inclusion of the manpower criterion in the strategic decision making process of technological projects is a complicated task because the full impact of the criterion appears during the operating stages of the project while the main strategic decision making is done during the early planning and implementation stages. Therefore, the requirement is to ensure that the manpower criterion, as well as other relevant criteria, is considered fully in the strategic decision making processes of technological projects irrespective of the location of their full impact along the project life cycle. This is the main thrust of this study. which may be summarised as follows:

 Aston University

Content has been removed for copyright reasons

The study is intended as a contribution to the task of integrating human resource planning with strategic decision making. The importance of this is widely recognized (e.g. Walker, 1978; Ettelstein, 1970), yet its achievement is still regarded as lacking (Kelleher & Cotter, 1982).

The Structure of the Thesis

In pursuit of the above stated aims, this thesis is structured as follows:

- Chapter 2 deals with the specification and analysis of the decision making context within which the technological development projects are planned and implemented.

- Chapter 3 deals with the outline of the decision making system prevalent in technological projects; the identification of its elements and the elaboration of their characteristics, interactions and behaviour.
- Chapter 4 deals with the evaluation of the established multiple criteria methods, models and techniques as to their possible contribution to decision making within the specified context.
- Chapter 5 deals with the formulation of an integrative methodology according to principles derived from the above chapters.
- Chapter 6 deals with the detailed analysis of the manpower criterion as a dimension within the integrative methodology.
- Chapters 7 and 8 deal with the assessment of the feasibility of the methodology in a typical developing environment - the Iraqi oil industry; the assessment includes a detailed specification of the Iraqi decision making context with special emphasis on the manpower resource - this is the subject of Chapter 7; and an appraisal of the possible application of the methodology to a specific technological choice situation - the prime movers selection case - this is the subject of Chapter 8.
- Chapter 9 deals with the general discussion of the features, effectiveness and implementability of the methodology. It draws some conclusions and indicates some directions for future work.

CHAPTER 2

THE DECISION MAKING CONTEXT
OF DEVELOPMENT PROJECTS

2.1 INTRODUCTION

The decision making context within which development projects are planned and implemented affects, directly and profoundly, the projects' decision making systems and their constituent elements and processes. The effects of the decision making context are usually reflected in the adopted styles and approaches of decision making; in the extent of authorities and the degree of participation of the various actors in the decision making process; and, in the criteria according to which the eventual decisions are made.

The decision making context may be specified by the determination of the state and behaviour of the following contextual factors (chosen because of their relevance to the planning and implementation of technological projects in developing environments):

- The prevalent approaches to decision making.
- The extent of planning and control.
- The mode of the project's ownership.
- The prevailing decision making framework.

The state of each of the above interrelated factors, and their combinations, determine to a large extent the decision making context within which development projects are executed and their relevant decisions are made. The analysis of the states that the above factors could assume in developing environments, and the effects that these states may have on the decision making system of development projects, are going to be dealt with in turn in the following sections.

The detailed analysis of the above factors should not only serve to specify the decision making context of development projects, but it should also constitute the theoretical assessment of the background against which the structure of the proposed methodology will be formulated.

2.2 DECISION MAKING APPROACHES

A decision making approach constitutes the basic strategy, methodology and procedure the decision maker(s) adopts when faced with a situation that involves search, deliberation and selection (Janis & Mann, 1977). The principal approaches in decision making have been reviewed by many authors (e.g. Cambis, 1979; Rosenhead, 1980a; Janis & Mann, 1977) with each adopting rather different principles to their classification. However, the following classification and outline of the principal approaches represent a synthesis of these reviews:

2.2.1 The Rational Comprehensive Approach: In this approach a decision maker establishes an agreed set of values, lists all the opportunities for actions open to him or her, identifies the consequences which would follow from each action, and selects the action whose set of consequences rates highest on the agreed values. Its rationality is deduced from basing concrete decisions on abstract values. Its comprehensiveness is due to the necessity of incorporating all values, opportunities and consequences in the analysis prior to decision making. This comprehensiveness is taken to require the specification not only of present actions, but also of decisions to be implemented at all later stages of the program or plan.

Following this approach to decision making will result in a "top-down", slow-moving, cumbersome and expensive process; where decisions at lower levels are justified in terms of more abstract values established at an earlier stage and not available for review without due disruption (Rosenhead, 1980a). This approach tends to encourage bureaucratic thought (Mannheim, 1966) and to require a strong administrative infrastructure, whereby the absence of such structures in most developing countries has raised serious questions about the efficacy of this approach in these countries.

Braybrook & Lindblom (1963) and Lindblom (1959) have criticised the

comprehensive approach as being impracticable because it makes undue demands on information, on the understanding of the social and political processes and on the policy makers' intellectual capacities; it makes an improper distinction between ends and the way to achieve them; and, it is based on the premise of a single, absolute and agreed set of values at all levels of the organisation.

2.2.2 The Incrementalist Approach: This approach is designed to avoid the need for decisions to be "right", by subjecting them to continuous adjustment. Lindblom (1959, 1965) has given a detailed account of the incrementalist approach in his analysis of "the art of muddling through"; his basic submission was that: when a problem arises requiring a change of policy, policy makers in governments or large organisations generally consider a very narrow range of policy alternatives that differ to only a small degree from the existing policy. The choice between alternative policies is then carried out by successive limited comparisons between these alternatives which are constrained by the means available to achieve them i.e. policy is formed as the result of a long chain of small steps.

The incrementalist approach is geared to alleviating concrete shortcomings in a present policy; firefighting rather than selecting the superior course of action (Janis & Mann, 1977).

Etzioni (1967) criticised the incrementalist approach because, according to him, it leads to incoherence and lack of direction; and, Dror (1964) criticised it on the basis that it tends to favour the already powerful and helps to stultify change by:

"giving ideological reinforcement to the pro-inertia and anti-innovation forces."

There are good reasons to doubt the feasibility of the incrementalist strategy, since it requires that: the results of existing policies are reasonably

satisfactory; there is continuity in the nature of the problem; and, there is continuity in the available means of dealing with it (Dror, 1964). However, organisational environments are usually turbulent; hence the above conditions are the exception not the rule. Rosenhead (1980a) stated that:



Aston University

Content has been removed for copyright reasons

The incrementalist strategy is based largely on consensus rather than on the actual values implicated by the issue. Although this may avoid some of the social evils of undemocratic centralised decision making, there is however a danger that it can prove to be a zigzag passage to unanticipated disaster since it is based largely on keeping fellow power holders reasonably contented and cannot be expected to do very much about the vital needs of politically weak groups (Janis & Mann, 1977).

Hence, if the strategy of incrementalism is the prevalent strategy in the project's decision making environment, then the emphasis will be on negotiation, interaction and consensus among the actors within the decision making system, and policies, regulations and guidelines are adjusted incrementally, continuously and in accordance with the prevailing consensus and agreements.

2.2.3 The Mixed Scanning Approach: This approach has been proposed by Etzioni (1967, 1968) as a synthesis of the stringent rationalism of the comprehensive approach and the "muddling through" approach of incrementalism. The approach distinguishes between two types of decisions: (1) "Fundamental" decisions that set basic directions; and (2) "bit" decisions that ensue after the policy direction is set, resulting in gradual revisions and sometimes preparing the way for new "fundamental" decisions. Each of these types of decision has its own

appropriate mechanism of analysis. For "fundamental" decisions there is a wide initial search (or scan) for relevant alternatives. These alternatives are analysed in low detail but with broad coverage; the alternatives are eliminated successively as crippling objectives (availability of means; values of the decision makers; political infeasibility) are revealed, until only one alternative remains. The "bit" decisions result from the fragmentation of the implementation of the "fundamental" decision into several sequential steps. Information resulting from the stages of implementation is monitored in detail, to decide whether a return to the higher level of more encompassing scanning is desirable.

Etzioni (1967) argued that this mixture of substrategies fits the need of democratic governments and organisations, and that in non-crisis periods, it is easier to obtain a consensus on incremental adjustments of present policies than to gain support for a new policy. But, in times of serious trouble and turbulence, a crisis stimulates intensive search for a better policy and serves to generate consensus for major changes of direction; hence, the frequency of high-level scans will increase if the decision environment suffer from rapid change. He also suggested that the mixed scanning approach may be an accurate descriptive model of what governmental policy makers actually do; a hypothesis which is challenged by Janis & Mann (1977), but neither they nor Etzioni offer any systematic evidence to support their respective claim.

Rosenhead (1980a) criticised the mixed scanning approach on the basis that it does not ensure that decision options will still be available when the re-decision points arrive; and, that it only emphasises tactical flexibility via "bit" decisions which are constrained by the preceding "fundamental" decisions.

In our opinion, the mixed scanning approach also suffers from the inherent sophistication and mechanistic mobility it assumes to be built in the decision making process; characteristics which are expected to be very rare in the decision making system of developing environments.

2.2.4 The Flexible Approaches: Rosenhead (1980a) classified operational research methodologies and the systems approach as falling firmly within the rational comprehensive paradigm. They are hence, according to him, at variance with their exhortations to achieve flexibility in planning and decision making. However, he singled out the work of Friend & Jessop (1976) as the most serious attempt in operational research to incorporate flexibility in planning.

Friend & Jessop (1976) saw in many decision situations a conflict between political pressure for commitment and the need for flexibility. They attributed the need for flexibility to uncertainties, which they classified as: (1) uncertainty as to knowledge of the present and future environment of the decision situation (UE); (2) uncertainty as to intentions in related field of choice (UR); and (3) uncertainty as to appropriate value judgement (UV). Hence, relating these uncertainties to the political, technical and administrative context of the decision situation. Friend & Jessop concluded that the appropriate approach to tackle complex decision situations, should:

"Not always look for complete solutions to well-defined problems, but rather to concentrate on the search for acceptable partial solutions which may go some way towards meeting the pressure of early commitment in respect of certain key choices, while leaving other options open until later stages when more information may be available."

They suggested a method for strategic choice incorporating two major technical components, AIDA and robustness analysis. AIDA (Analysis of Inter-Connected Decision Areas) is an approach to the finding of solutions where there are many combinations of choices to be considered. It offers a way of handling complex decision situations which can be structured into a number of identifiable decision areas, where options selected in the different areas may be incompatible. It provides an algorithm for listing all compatible complete sets of options or, where these are too numerous, for selecting the most promising of these solutions on a multiple-criteria basis. By listing all feasible solutions AIDA is geared for the

production of "action sets" instead of full solution to the decision situations; this may leave the decision maker with a degree of flexibility in the face of uncertainty, and it overthrows the concept of optimum solutions, which could constitute, as in the words of Rosenhead (1980a):

"A barrier to public participation in planning."

The second component of Friend & Jessop's method is robustness analysis. The "robustness" of an initial decision is defined as (Rosenhead, 1980a):

"the proportion of all known good or acceptable system states which will still be available after implementation of that decision."

The method treats decision making as essentially sequential, and it consciously adopts the "flexibility criterion" as one of the main bases for the selection of decisions, whereby (Friend & Jessop, 1976):

"Other things being equal, flexibility is a good thing, even to the extent of retaining extra options which at present do not appear very desirable."

The "flexibility criterion" is measured by the robustness score of the initial decisions and since all other things are rarely equal, a high (but not necessarily the highest) score may be the requirement (Rosenhead, 1980a). The Friend & Jessop method has been chiefly applied to planning problems in local government (Friend & Jessop, 1976; Centre for Environment Studies, 1970 and Bunker, 1974).

Rosenhead (1980a), noting the absence of proper consideration of the critical concept of "flexibility" in most approaches to decision making and planning, advocated that the appropriate approach to decision making should have the following characteristics:

"It should be bottom-up in structure and facilitating participation; it should be non-optimising, and be based on establishing a set of feasible solutions; and it should accept the uncertainty of future states, attempt to keep options open, and aim at a loose fit on the planned for activities."

He went on (Rosenhead, 1980b) to outline an integrated methodology which incorporated the above characteristics. His methodology is based on robustness analysis with uncertainty as a key element, and he claimed that it is:

"A language for continuing strategic choice."

By advocating that planning should aim at satisficing and not optimising, Rosenhead stresses that analysis, trade off, identification and modelling should not need to aim at the levels of detail and accuracy which would be needed for optimisation. Not only should this reduce the prior requirement of an extensive data base, but the methodology will actually permit sequential development of a data base. According to Rosenhead this should make the approach especially suitable for Third World countries:

"whose fluidity of development is matched by the absence or unreliability of much social survey information."

The non-technical nature of the methodology; its forward look which should guard against the development of unforeseen crises; and its preservation of potentially fruitful options, are all advantages of the robustness analysis methodology. But, it requires decision makers to learn to live with uncertainty and postpone commitment until it is absolutely necessary; principles that go against their desire and need to get things done and their natural propensity for early commitment - a point stressed by Friend & Jessop (1976).

The robustness analysis approach has been applied to: industrial location and investment (Gupta & Rosenhead, 1968; Caplin & Kornbluth, 1975); urban planning (Centre for Environment Studies, 1970; Friend & Jessop, 1976); and personal education planning (Rosenhead, 1978).

The Friend & Jessop method and the Rosenhead methodology are attempts to operationalise the consideration of the flexibility concept in planning and strategic decision making. However, their adoption and application in the developing environments have not yet been indicated. This should not reflect on the importance of the flexibility criterion in decision making in these environments, since decision makers may still give flexibility its due weight without necessarily adopting the formal approaches of Friend & Jessop or Rosenhead.

2.2.5 Other Approaches: Other relevant approaches to decision making and planning may be outlined briefly under the following headings:

(a) The learning-system approach: This approach is based on the premise that the result of engaging in rational planning and decision making is learning, including self learning, which should increase the capacity of the organisation to attain its goals and aims.

Faludi (1973) developed a model for planning agencies based on the model of the human mind as a learning system. He viewed planning as a continuous process with increasing variety and complexity (reflecting the widening of the range of goals); where information from the environment is compared to already held images and goals, and programmes selected and applied to produce changes in the environment, hence affecting the future information received and thus completing the feedback process. If the changes produced are not sufficient, a higher level of learning that includes the changes of goals and images may be necessary.

The learning basis of the Faludi cybernetic model coincides with Beer's (Beer, 1969) assertion that decision making is basically a process of adaptation and continuity. Beer's overriding concern with adaptation was justified thus:

"The firm is always dangerously short of information; about itself, about its environment, about what is going to happen and about when the crunch will come."

He went on (Beer, 1979) to explain the role of the main elements of his viable system model - systems 1 to 5 - in the process of adaptive planning and decision making. The cybernetic approaches are abstract approaches that generally emphasise adaptation, learning and continuity and are mainly concerned with the viability, equilibrium and control of the system under perturbations from the environment.

(b) The revolutionary approach: This approach was formulated by Ackoff (1957 & 1977) and was oriented towards revolutionary development. He postulated that the principal obstructions to development are cultural and political and not economic or technological. To overcome these obstructions, he suggested the concept of "idealized design" of the system planned for. This design should be carried out free from any financial, political, legal, social or other types of constraints (apart from technological feasibility and operational viability) and the design should be the best the designers can think of now. Furthermore, the system should be designed so that it is capable of learning from and adapting to its own experience.

Ackoff envisaged that designs produced by this process often become mobilizing ideas "a crusade" because; the process facilitates widespread participation; idealization tends to generate consensus due to its focus on ultimate values; idealization induces more creativity in design due to the absence of the feasibility criterion; and, idealization converts the apparently impossible into the possible and mobilises a collective effort to obtain it.

The approximation of the idealized design may be based on: specification of the means by which the desired ends can be obtained; determining how and when resources will be obtained and used; and the design of implementation and control.

Although the Ackoff approach may be ideal for strategic decision making in developing environments, especially during the early phases of options and alternatives generation, however, its adoption has not been indicated formally, but that does not rule out the informal use of similar approaches, especially during the creative stages of decision making.

The decision making approach prevailing at any of the relevant levels - organisational, sectoral or national - will have direct effects on the project's

decision making system. These effects may be reflected in; the extent of authorities, freedom and influence enjoyed by the actors within the project's decision making system; the easiness and accessibility (or otherwise) of policy making and adjustments; and, the nature and form of interactions between the project's decision making system and its environmental context.

2.3 PLANNING AND CONTROL

The decision making system of any development project is greatly influenced by the extent and degree of planning and control prevailing within its organisational, sectoral and national contexts. This influence manifests itself via; the extent, and degree, of the authority and freedom of choice the project's decision makers enjoy; the degree of their commitment to meet prescribed targets; and the nature of their concerns and objectives.

'Planning' has been defined in many ways, but the Cleland & King (1983) definition captures its general meaning in the general organisational context:

"It is an activity consciously programmed into an organisation's continuing activity and having as its focus the objective consideration of the future."

And the Myrdal (1964) definition captures it in the national context:

"A conscious attempt by the government of a country - usually with the participation of other collective bodies - to coordinate public policies more rationally in order to reach more fully and rapidly the desired ends for future development."

Most, if not all, developing countries adopt the approach of central planning and control to steer and direct their national development. In a developing context, planning is usually thought of as a powerful and indispensable means of giving expression to the country's priorities and a framework within which different instruments of policy can be coordinated, in order to achieve maximum effectiveness in reaching society's goals and aspirations. It has been suggested (e.g. Kadhim, 1974) that the important question confronting the

developing countries is no longer whether to plan or not, but rather the choice of an appropriate development strategy.

Planning is not only confined to developing countries; in Western Europe, where it had a chequered record, it is now on the agenda of major parties of the European left (Holland, 1982); and in the communist and socialist countries rigid and highly central planning has been practised for generations and has become a way of life and an established method of governing and control.

The degree and scope of central planning varies from country to country. The spectrum ranges from loose "indicative planning" at one end, to the fully fledged socialist countries at the other.

"Indicative planning" is a flexible form of planning and was adopted by France as a means of accelerated growth after the second world war; the French experience is generally regarded as being a success, especially in fostering post-war industrial development up to the 1960s (Kindleberger, 1967; Estrin & Holmes, 1982). Kuwait has also adopted a similar form of planning to steer its industrial development since 1967 (Asker, 1982).

The basic rationale for this form of planning is that, in the face of the all-pervasive uncertainty of the world economy, it is impossible to give precise quantitative objectives, or even forecasts, over the medium term. Instead, it concentrates on providing a way to anticipate problems ahead of time, and to permit a systematic reflection on what is actually possible; it does that by providing indications as to possible future scenarios, the expected outcomes and trends of the principal parameters within these scenarios, and the expectations and directions that the private and public sectors should aim for and follow (see Estrin & Holmes (1983) for a full explanation of the French experience). This form of planning is not binding and mainly on terms that suit the private sector (Holland, 1982).

The European left parties have adopted a stricter form of planning, which

is, in the words of Holland (1982):

"less than imperative but more than indicative."

It could be termed as planning-by-agreement and involving government, managements and trade unions. Such planning agreements are the key elements in the programmes of the Spanish socialists, the Greek PASOK and the Italian socialists; even the French socialists put them on the statute book in 1982 (Holland, 1982).

At the other end of the spectrum, is the central comprehensive planning as practised by the socialist countries. Constable (1984) has criticised this form of planning as practised in the Soviet Union because it maintains, according to him, an inflexible planning structure which creates two fundamental problems: Firstly, despite all the efforts to develop large scale systems analysis, economic models and the use of O.R. techniques, it is simply beyond the capability of human intelligence to plan centrally something as complex and as geographically flung as the Soviet economy. The attempts lead to breakdowns at the boundaries between sectors of the economy and between enterprises within the sectors. Secondly, the planning system deprives the producers of goods and services of a market place response. Although it is accepted in western economies that the market place is neither free nor determining in the classical sense, it does give major areas of contacts between customer and supplier. However, Constable added that:

"One of the great advantages of the central planning system, the Soviet managers stated, was that once a successful organisational design had been produced, it could be rapidly applied in a very wide range of organisations."

Most of the developing countries forms of planning are somewhere in the middle of the above spectrum. The central planning systems in these countries are usually geared to the guidance and coordination of their development efforts. This central planning is not confined to countries which follow a certain political path or system; countries with diverse political systems have adopted this form of

development management. While countries like Algeria, Iraq, Sudan and Syria formulate their policies with a "social orientation", countries like Saudi Arabia, Morocco and Tunisia follow more of a "market orientation", yet all of these countries adopt the approach of central planning for their development. The difference rests mainly on the role of the public sector in the economy (Sherbiny, 1981).

The outputs of the planning process are a series of "plans", which have been defined as (Friend & Jessop, 1976):

Content has been removed for copyright reasons

These plans are usually prepared by central planning ministries or commissions.

Tinbergen (1967) outlined the principal functions of these agencies as:

- (1) Preparation of plans.
- (2) Conducting investigations and surveys.
- (3) Formulation of regulations and standards for others to follow.
- (4) Coordination of, and advice on, economic activities.

He also categorised the plans prepared by these agencies as; perspective (long term) plans; medium term (usually five years) plans; and short term (usually yearly) plans. The long term plans are usually a statement of the basic aims that the country is striving for over the next 15-20 years, and they usually contain an overview of the relevant forces, the effect of which can be estimated with reasonable certainty over a long period e.g. growth of the population; the influence of education; the growth of technological factors. An example of this type of plan is the U.S.S.R. perspective plan 1960-1980 which was debated at the 22nd Congress of the Communist Party of the Soviet Union (Tinbergen, 1967). The medium term plans, with a planning horizon of 5-6 years, have greater precision than the perspective plans. Their usual tendency is to emphasize the development

of those sectors that are regarded as fundamental to the country's prosperity and progress. In the indicative planning approach (such as the French), the five year plans give loose indications of the state of economic parameters over the planning horizon and expect the sectors/industries to take these into consideration when they prepare their plans. But, most developing countries go much further than that; for example, the Iraqi national development plans of 1970-1974 and 1976-1980 stated detailed objectives and targets for all the sectors and activities in the economy, and outlined detailed allocations of the principal resources (financial and human) to each sector over the planning horizon (Iraqi official Gazzette, 1970 & 1977). The short term plans (usually yearly) usually concentrate on setting out how the government policy should be put into effect. Intentions are stated as concrete development projects or as proposed legislation. The preparation of these short term plans is usually left to the planning units in the various sectors, who prepare their individual plans in accordance with the targets, goals and objectives of the five year plans prepared by the central agencies.

The medium term central national plans are usually translated by each sector into its respective sectoral program covering the same planning horizon. These sectoral programs may be either: A synthesis of the plans of the organisations that make up the sector (which is usually a ministry with a specified function), where these organisational plans are formulated according to the central national plan; or, produced by a sectoral central planning organisation that covers the planning activity of the sector. The implementation of the national plan is achieved by the execution of these sectoral programs, where a development program consists essentially of an interrelated series of development projects (Goodman & Love, 1980). For example, a road-building construction program can involve a string of road construction projects linked in time, proximity and function. Hence, for the implementation of the central plans and sectoral programs to be successful, they must be successful at the "grass roots"

level - the project level. Projects are thus (Goodman & Love, 1980):

"The building blocks of development ... (without them) development plans become only empty objectives remaining for ever elusive."

Hence, the nature, characteristics and style of the approach higher authorities adopt to achieve their aims and objectives will have direct effect on the decision making system of the individual projects which are basically the only means by which the aims and objectives of development could be brought to fruition.

2.4 THE MODE OF OWNERSHIP

Serageldin (1981b) stated that the path of development of any country, could be divided into three stages:

- (1) Infrastructure build-up.
- (2) Operation of major enterprises.
- (3) Stabilised growth.

He also identified most developing countries as being in stage (1); the oil developing countries especially so, due to the recent increase (since 1973) of investment capital. This stage mainly concerns the building-up of the country's infrastructure (roads, ports, power systems, etc), and initiating some planned large scale industrial enterprises which, it is hoped, will diversify the national economic base upon their completion.

The above tasks as well as the realisation of the general principal aims of any development effort (which have been enumerated by Sears (1973) as; the reduction of poverty; the eradication of unemployment; the removal of inequality), represent a degree of challenge that is beyond the capability of the private sector of any developing country. Indeed, it is an agreed principle that national development could not be entrusted to market forces; this is mainly because of:

- (1) The scarcity of resources on the national level. This scarcity will drive societal forces to achieve central control (i.e. governmental) of their allocation (e.g. Iraq has developed a highly centralised allocation system for its scarce high level manpower (Abed & Kubursi, 1981)).
- (2) The newness, inexperience and selfishness of the national private sector and its tendency to invest only in high yielding and quickly maturing investments. Ackoff (1977) outlined the attitude of the Mexican private sector as seeing itself in business to do business and not national development, or social welfare, or protection of the environment; and to comply with the law and to pay taxes and the less of both, the better. He went on to emphasize that; for significant national development to take place:

"Either the private sector's selfishness or the government's inefficiency and ineffectiveness must be overcome".

- (3) The enormity and complexity of the development problem and the importance of non economic considerations in the decisions and choices involved. Most development projects have to possess technical over-capacity (i.e. operating below the economic optimum) and produce external and higher order effects (of societal advantages and disadvantages) which make them unattractive as private investments when considered on economic motives alone (Tinbergen, 1967); the word "private" implies that a private entrepreneur considers only the private marginal return on investment and not its marginal social returns, Scitovsky (1954) emphasises that these two returns are not the same in an underdeveloped setting where some of the resources are assumed to be unemployed, he went on to stress that:

"In general, in an underdeveloped setting, the private profitability of investments understates its social desirability."

Hence in underdeveloped settings, the functioning of the price mechanism is seriously impaired, and prices cease to be reliable parameters of choice. They, in fact, transmit the wrong information and therefore perpetuate the state of disequilibrium. Little & Mirrlees (1979) summarised the differences between developed and developing settings as follows:

"In developing countries it is assumed that profits are a reasonable measure of net benefit.... In developing countries, the actual prices are very bad reflectors of social costs and benefits."

They went on to advocate an evaluation method based on a system of shadow prices.

- (4) The underdevelopment of the legal, institutional and political systems, resulting in the difficulty of handling shareholdings, investments and distribution. Hence, people will not trust others to manage their resources; resulting in the non-accumulation of capital and non-formation of large investments (Tinbergen, 1967).

Due to the above reasons most, if not all, developing countries depend on the public sector to motor their economy and to carry the momentum of development. However, an important and vital share still has to be left for the private sector. A fact Mathur (1971) articulated thus:

"planning does not imply that the government must step into production of all items. Once it takes the lead in certain projects, the tempo in the related activities can pick up much more easily than if no plan or coordination by the state existed."

Indeed, the definition of the private and public sectors has been identified by many development economists (e.g. Myrdal, 1968; Higgins, 1968) as one of the vital elements of a successful strategy of planning. Higgins even quoted figures of the ratio of public investments to total investments that resulted in successful development and concluded that:

"Incentive systems seem to work best in predominantly private enterprise or predominantly socialist economies."

The definition of the roles of the sectors has also been at the core of the Iraqi planning efforts since 1968 (Arab Ba'ath Socialist party (ABSP), 1974 & 1982), with the overriding importance given to the public sector which was allocated 90 percent of the total investment resources in the 1970-1974 national development plan (Abed & Kubursi, 1981).

The preponderance of the public sector in the developing economies ensures that most of the major development projects will belong to it. This mode of ownership creates an atmosphere of decision making that directly affects the project's decision making system. This atmosphere affects; the actors' value judgements, motives, objectives, accountabilities and performance measures; the range and characteristics of the options to be considered; and the basis according to which the options will be evaluated and decisions made. This preponderance also entails that efforts directed towards improving and refining the decision making system of major technological projects in developing environment, should focus on project environments that are characterised by public sector ownership.

2.5 THE DECISION MAKING FRAMEWORK

The decision making framework of any project may be specified in terms of the set of policies, regulations and guidelines that the project's decision makers have to adhere to and the prevailing ethos under which the decision makers operate. These interrelated concepts are going to be analysed, and their effect on the project's decision making system explained, in turn.

A "policy" has been defined in many ways, but the Friend & Jessop (1976) definition of a "policy" as relating to:

"Intentions wherever situations arise which are seen to belong to a certain defined class"

captures the essential meaning that is attached here to this concept, i.e. policies are pre-planned, deferred decisions waiting to be activated by the occurrence of specific situations for which they were designed (Starr, 1966). In other words they represent the "automatic" response of the system to certain identifiable conditions without the activation of higher levels of selection and control (Faludi, 1973). These definitions are process oriented ones and should be differentiated from the meaning some authors (especially economists) attach to the concept of policy. They usually regard it as the all-encompassing concept e.g. Tinbergen (1967) defined policy as:

"It is described in terms of the whole body of its aims and the means by which these aims to be achieved."

The determination of policies represents the highest level of planning and decision making in any organisational context; Beer (1979 & 1984) defines the function of the highest subsystem in his viable system model (system 5) as policy formulation, which, in his words, represents:

"the collective will and judgement of the organisation";

Cleland & King (1983) identified policy formulation as the highest level of decision making, and they saw it as being concerned with "ought to" decisions.

Decisions concerning the implementation and planning of development projects are constrained and governed by the policies that are relevant to the issues and domains covered by the decisions. The formulation of these policies is usually a complicated process of interactions between ideals and objectives, the environment and its relevant factors, and the prevailing structure of the system. Modification of these policies is done via a process of dialogue and learning. Dialogue occurs when the organisation finds itself too severely restricted by the present policies (Schwenk & Thomas, 1983); the dialogue is carried between the planning and implementing subsystems and the higher subsystems of policy, intelligence and control (see Beer VSM model, Beer, 1979). This dialogue results

in learning which is achieved by monitoring the organisation and its environment; the signals received will determine whether the policies are modified to achieve the same ideals and objectives (single loop learning) or the ideals and objectives themselves have to be modified (double loop learning) and hence produce different policies.

Regulations, standards and guidelines are all treated here as variations on the concept of "policy"; they are assumed to differ only as to their degree of specificity (e.g. a standard could be a given figure above which a given variable should not be allowed to rise - such as figures concerning allowable concentrations of chemical waste in rivers); and the necessity for them to be adhered to (e.g. guidelines may contain a higher degree of freedom than policies).

"Ethos" has been defined by Beer (1979) as:

"providing implied answers to the questions that people are asking in other subsystems of the organisations."

According to him, it provides cohesion throughout the organisation and has the effect of encouragement or admonition, of reinforcement or depletion. He also related it to the continual interaction that occurs between system 5 (the policy formulation subsystem) and every one else in the organisation. The "ethos" that runs through the organisation may be regarded as the paradigm through which management at the various levels approaches its decision making and planning activities. This paradigm deals with situations and cases that are not covered by the prevailing policies, regulations, guidelines and standards; since these cannot (and should not) cover every case and contingency. The principal aims of the "ethos" are; the achievement of harmony, in goals and outlook, between the various levels of the organisation; and, the tuning of these levels to the organisation's main goals and objectives. These aims may be easily achieved in

the private sector where the organisation's "ethos" are usually geared towards the maximization of profits and turnover, however, in the public sector, the situation is much more complex, since the basis of decision making usually involves multiple criteria which are diverse and usually pose contradictory characteristics. These diversities and contradictions make the achievement of harmony of decision making in the public sector much more difficult, especially when the aim is to maximize the social benefit for the whole country (Little & Mirrlees, 1979).

When dealing with identifiable and expected situations, the harmony in decision making throughout the various decision making levels (national, sectoral or organisational), and the tuning of these levels to the principal goals and objectives, are achieved via the system of policies, guidelines, standards, procedures and regulations. However, when dealing with unidentifiable, unexpected and uncertain situations, the decision makers can only depend on the "ethos" that is prevalent in the organisation and its context. Hence, "ethos" assume crucial importance in the developing countries who are trying to achieve fast progress and change in a turbulent, uncertain and constantly changing environment. The conscious manipulation and formulation of the "ethos" represent the biggest challenge to these countries. A challenge fully appreciated by Ackoff (1977) who insisted that development could only be achieved via a crusade aimed at the reformulation and modification of the prevailing attitudes and "ethos".

At the beginning of this chapter, it was assumed that a project's decision making context may be specified by defining the prevailing states and characteristics of the above contextual factors. This entails that decision making contexts may take any of a large number of possible forms. However the most relevant and representative contextual form to developing countries is the context which is specified by the following states of its constituent factors:

- (1) The prevailing decision making approach is close to the rational comprehensive, where policies and directions are set for the whole planning horizon i.e. reformulations are difficult to achieve, once policies are set.
- (2) High degree of central planning and control characterised by high commitment to achieve the targets and goals set by the central plans and the strict adherence to predetermined constraints and schedules.
- (3) Major technological projects are executed within the public sector. Hence enforcing wider bases for decision making and the imperative consideration of multiple criteria in alternative selections.
- (4) Strict adherence to established policies, regulations and guidelines and to the prevailing ethos at all levels.

The above context is common to many developing countries - Iraq is a typical case. It will be regarded as the prevailing context within which the proposed integrative methodology has to contribute to the improvement of decision making of technological projects in developing environments. As mentioned earlier, the importance of the specification of the project's decision making context lies in the effects the context has on the project's decision making system and its constituent elements. The exposition of the project's decision making system and its constituent components are the subject of the next chapter.

CHAPTER 3

THE DECISION MAKING SYSTEM
OF DEVELOPMENT PROJECTS

3.1 INTRODUCTION

The planning and implementation of projects represents the actual manifestation of any development planning effort. The goals and objectives of the central plans and the strategies of the sectoral programs will only be translated into reality if the development projects are implemented.

This chapter is devoted to the outline of the decision making systems within which development projects are planned and implemented in the developing environment. The elements of these systems will include the actors involved and the stages of the project's planning and implementation cycle. These principal elements will be related to each other according to a "responsibility" scale; the degree of this responsibility will be analysed as to its impact on the actors' attitude towards, and perception of, the salient criteria according to which decisions are made about the project. In short, this chapter will be regarded as specifying the problem tackled by this research.

However, before embarking on outlining the decision making system of development projects, it is necessary to devote the earlier sections to the outline of the principal characteristics of these projects and the possible forms of their management.

3.2 THE CHARACTERISTICS AND MANAGEMENT OF DEVELOPMENT PROJECTS

3.2.1 Definitions: There are many definitions advanced for the word "project", but they all agree on its uniqueness, its limitation in time and space and its being goal-led to achieve a specific purpose.

For example:

- (1) "A set of activities limited in time and space and converging on a given goal" (Cuenod, 1980).

- (2) "A relatively narrow, specifically approved, limited-life activity.... which occurs within a set time frame, and constitutes a one-shot undertaking in a largely unfamiliar area" (Goodman & Love, 1980).
- (3) "Any item of investment which can be separately evaluated" (Little & Mirrlees, 1976).
- (4) "A complex effort to achieve a specific objective within a schedule and budget target, which typically cuts across organisational lines, is unique, and is usually not repetitive within the organisation" (Cleland & King, 1983).

In our context, a project will be defined as:

"A set of tasks that is necessary towards the achievement of a given goal, it is not a permanent entity, but rather an activity whose purpose is to work itself into dissolution after its objectives have been accomplished."

In this sense, a project is a unique set of tasks which are goal-led and which involve no alternatives at the objective level; the decision involved at this level are only of the type "approved" or "not approved".

For example, a project could be:

"The full utilization of the natural gas of oil field X by the year Z".

3.2.2 The Size of Development Projects: Any serious attempt at development will involve, by necessity, large development projects; a point articulated by Tinbergen (1967) thus:

"Development must take place in leaps and bounds.... The need for big pushes or big leaps forward has been emphasised, implying that small investments are both insufficient to promote any genuine development towards a modern economy and also inherently dangerous in that they tend to be squandered on small and less attractive objects."

In most developing countries, the development effort is generally directed towards the building-up of the country's infrastructure and/or the diversification of its economic base (Serageldin, 1981b). The infrastructural projects are large by nature, and the projects that can achieve the diversification of the economic base, have to be large scale industrial enterprises. This entails that the relevant development projects are generally large scale and complex.

3.2.3 The Execution Modes of Development Projects: The size and nature of development projects make it necessary for the developing countries to delegate their planning and execution to the public sector organisations (even in countries which follow a market orientation). This is due to the weakness of the private sector (see section 2.4) on the one hand, and to the unattractiveness of delegating the task of development to international organisations (multi nationals) on the other (since the environment and regulations demanded by these multinationals raise serious questions about the country's independence, well being and future prosperity).

Public sector organisations in developing countries do not usually possess the requisite capability to carry out the complex tasks involved in the stages of the project cycle. These organisations will thus have to contract out some (or all) of the tasks involved either to national or foreign bodies. The form and extent of the relationship between the public sector organisations and these bodies can vary from the "turnkey project" type, where the contracting body is responsible for the execution of all the project cycle up to the stage of full operation; to a short term contract to carry out a specific task under the full supervision and control of the responsible public sector organisation (Goodman & Love, 1980).

In the planning and execution of large and complex development projects, the developing countries find themselves in a position where they have to depend extensively on the expertise and abilities of foreign organisations and companies (mainly from the industrialised developed countries). This dependence, which raises vital issues relating to national independence, the national free will and the national interests, has to be reconciled conscientiously and wisely with the pursuit of development (ABSP, 1982).

If the "planning" of projects is taken as covering the tasks involved in their identification and formulation, and if the "implementation" is taken to cover all the remaining stages up to the full operating state, then table 3.1 may be

constructed, which reflects the general nature of the projects which are executed under each combination of foreign and national bodies.

The focus of this research is on large development projects with high technological components. Hence the mode of execution that is going to be assumed in the rest of this thesis will be:

"National Planning"
and "Foreign Implementation".

3.2.4 The Management Forms of Development Projects: The public sector organisation entrusted with the execution of a large and a complex project will require an organisational set-up to manage its responsibilities during both the planning and implementation stages (for although the implementation is classified as "foreign", there are still vast responsibilities in the areas of coordination monitoring, directing and organising, that have to be carried out (Goodman & Love, 1980)). The internal organisational structure of this set-up usually follows what has been termed as a "matrix" form of organisation, whereby staff play dual roles; as part of the project management team; and as functionaries in their own specialities (Cleland & King, 1983). This organisational set-up may take one of the following forms:

(1) Task Force: This force, preferably placed under the command of one project leader, usually has a life span which corresponds to the active duration of the project itself; hence the team is dispersed once the work has been finished (Lock, 1968). The task force is usually formed to ensure that projects which have been evaluated, selected and funded are appropriately executed on a day-to-day basis (Cleland & King, 1983). The task force is a "functional teamwork" approach to organisation, usually cuts across functional divisional lines, and was advocated in the early sixties due to the inadequacy of the classical line-staff concept in

| PLANNING | IMPLEMENTATION | NOTES ON THE NATURE OF PROJECTS |
|----------|----------------|--|
| Foreign | Foreign | Usually projects financed by and executed for the foreign organisation e.g. multinationals |
| Foreign | National | Projects financed by aid agencies and usually with low technological content and in the social and agricultural sectors |
| National | Foreign | The usual form of execution of large development projects with high technological content. This form is typical in the public sector of oil producing countries |
| National | National | The usual form of execution of projects with low technological content and small to medium scale. Poor developing countries follow this form because of necessity, and rich developing nations because of their desire to accumulate experience and technical know-how |

Table 3.1: Modes of Project Execution in Developing Countries

project management (Fisch, 1961). Specific personnel required for the task force, are usually seconded for a period from their functional duties; this secondment could be on a part-time or full-time basis for the project duration. It has been suggested (Cleland & King, 1983; Goodman & Love, 1980) that this form of management raises serious questions regarding division of loyalties, sharing of decisions, sharing of accountability and sharing of results between the project team and the functional departments.

(2) Project Management Units: In organisations where project execution is an ongoing process, due to the multiplicity of such projects and their life cycles, permanent units may be set up to pool their project management expertise. These units are usually made up of: technical experts and specialists on secondment from their functional departments; and project leaders and coordinating officers who are permanently attached to the units. However, depending on the situation, these units might develop their own in-house technical capabilities (Goodman & Love, 1980). This form of project management is typical of the large oil companies of the Middle East, where the execution of large technological projects is an ongoing phenomenon; such a unit exists in the author's employing organisation - The Southern Petroleum Organisation, Basrah, Iraq.

(3) Project Organisations: Due to the size and complexity of most technological development projects, most national organisations will find themselves incapable of carrying out the interfacing required with the foreign implementors (and the few who do manage that are thus regarded as national assets (Goodman & Love, 1980)). Therefore, in some developing countries, special organisations have been created to manage this interface in the sectors that are undergoing rapid development. Such an organisation will be responsible for the management of the implementation of large projects in its respective sector.

Some developing countries regard these project organisations as the first step towards achieving a national capability for project implementation. (The organisation responsible for the implementation of projects in the Iraqi oil sector is called S.C.C.O.P. (State Company for the Construction of Oil Projects)); one of its senior managers told the author in December 1983 that a principal objective of the creation of S.C.C.O.P. was the accumulation of experience and the pooling of effort necessary to achieve a national capability for the implementation of oil projects).

These project organisations usually liaise with project units in the organisation on whose behalf the project is executed on the one hand, and the foreign companies and bodies that are carrying out the actual task of implementation on the other (Goodman & Love, 1980).

The management form adopted may be one of the above forms or the variety of their combinations and adaptations. The important point is that due importance and attention should be given to the forms and methods to be adopted in the planning and implementation of projects, since, as in the words of Goodman & Love, 1980):



Aston University

Content has been removed for copyright reasons

In practise, the chosen project management form is superimposed on the existing functional organisation and provides a focal point for the decision making and execution phases of a particular project. The nature of the job of managing a large project forces this integration (Cleland & King, 1983).

3.3 THE PRINCIPAL ELEMENTS OF DECISION MAKING

The principal elements constituting the decision making system of a

development project may be identified as:

The "stages" - of the project life cycle

The "Actors" - responsible for the execution of the project.

These elements are going to be reviewed, classified and analysed in turn.

3.3.1 The Stages: The project life cycle, from its identification to its post operating refinements, is usually divided into distinct and interrelated stages. The modes adopted for the classification of stages are usually related to the nature of the project and the purpose it endeavours to achieve. For example, Porter et al (1980) identified the stages of a typical technological development project as: planning, construction, implementation, secondary development and eventual disposal. Cleland & King (1983) similarly identified five stages of development of weapon and defence system as: conceptualisation, validation, full scale development, production and deployment.

Some authors have suggested specific modes of classification for development projects. The most widely quoted is the United Nations Industrial Development Organisation (UNIDO, 1975) classification of stages and phases shown in Table 3.2, together with objectives for each phase. A more elaborate framework within which to view development projects has been suggested by Goodman & Love (1980). They called it "The Integrated Project Planning and Management Cycle - IPPMC), and they used it to ascertain the underlying unity of process which is:

"The same for all projects, even though each one is different."

They divided the IPPMC into four major phases:

- (1) Planning, appraisal and design.
- (2) Selection, approval and activation.
- (3) Operation, control and handover.
- (4) Evaluation and refinement.



Aston University

Content has been removed for copyright reasons

programme continuity)

Source: United Nations Industrial Development Organization (1975):
The Initiation and Implementation of Industrial Projects in
Developing Countries: A Systematic Approach, United Nations,
New York, p.6.

Table 3.2: Phases, Stages and Objectives of Industrial Development Projects

Fig 3.1 illustrates the relationship among the phases of the project cycle, the task within each, and the overall dependency on central policy issues. They (Goodman & Love) emphasised that the project cycle is an ideal model, and that not every project will confirm precisely to it. They stressed that the tasks of the cycle are not necessarily sequential, and not all of them are necessarily required, since (in their words):

"The head of a country might decide that a dam is needed for a hydro-electric project. The leader decides to have it built and instructs subordinates accordingly, thereby bypassing the first two tasks in phase 1 of the cycle."

They also emphasised that a continual feedback and dependency relationship does exist among the tasks, with each task dependent upon and influenced by the others.

In the context of technological projects in developing countries, the classification shown in table 3.3 is proposed; it contains the salient features of the UNIDO and Goodman & Love approaches although it is simpler and more condensed than either of them. The basis according to which these stages have been classified is that between the various stages are decision points at which explicit decisions are made concerning whether the next stage should be undertaken, its timing, etc. For example, a decision has to be made after the completion of the "formulation" stage as to whether to proceed or not, before the stage of "conceptual design" can actually begin.

Following is a brief examination of each of the five stages and the tasks they include, in turn:

Stage (I) - Formulation:

This stage includes the identification of the project, which may perhaps be: to satisfy a certain need; to implement a certain policy; as a response to certain requirements; or to utilize a certain opportunity. It also involves the



Aston University

Illustration has been removed for copyright restrictions

Source: Goodman L.J. & R.N. Love (1980): Project Planning and Management: An Integrated Approach, Pergamon Press, Oxford.

Fig 3.1: Integrated Project Planning and Management Cycle (I.P.P.M.C.):
The Four Phases

| PHASES | | STAGES | TASKS |
|-----------------------|-----|----------------------|--|
| <u>PLANNING</u> | I | FORMULATION | The identification of the project. The determination of its technical and economic bases, its objectives and outputs and estimates of the resources required. |
| | II | CONCEPTUAL DESIGN(S) | Determination of the project concept, its dimensions and parameters. And to determine as accurately as possible, cost, schedule, performance and resource requirements. Relevant alternatives assessed and classified. |
| <u>IMPLEMENTATION</u> | III | DETAILED DESIGN | The preparation of blueprints and specifications for construction, facilities and equipment. Preparation of work schedules and operating plans. Determination of all required inputs. |
| | IV | CONSTRUCTION | The management and mobilisation of the resources required to facilitate construction, and the actual construction and installations of buildings, equipment and systems up to the "testing" stage. |
| <u>OPERATION</u> | V | COMPLETION | Preparation of the project for phasing out and hand over to the operating organisation. The development of resources required to support the project during the full operational stages. |
| | | OPERATION | Not a project stage, but listed to show the cycle continuity. |

Table 3.3: Suggested Project Stages for Technological Development Projects

development, in broad terms, of the objectives and outputs of the project and an estimate of the various resources required to achieve the project's objectives. It also usually includes a feasibility analysis to determine whether the project is capable of achieving its objective within the limits imposed by decision makers and whether it will proceed further. Estimates of the resources required, and basic decisions about size, location, technology and administrative needs must be also made before the project feasibility is decided.

The output of this stage is a decision as to whether the project is "approved" or "not", and if approved, then according to what form, schedule and cost it should be executed.

Stage (II) - Conceptual design:

This stage commences once it has been determined that the project will continue (i.e. approved, funded and scheduled). This stage establishes the basic programs, allocates responsibilities, determines activities and resources, and sets down the areas of priority and functions to be carried out. All inputs relating to the project, including personnel, skills, technical input, etc, are determined at this stage. Assessment of environmental factors, social criteria, technological requirements, and procedures, must be carried and included. In short, this stage simply sets out in more detail what it is that the organisation wants to do, when it wants to do it, how it will accomplish it, and what the cost will be, i.e. this stage allows the organisation to fully conceive and define the project before it starts to put it physically into its environment.

The output of this stage is usually a document called "the project report" or "the project tender document". In the case of large technological projects, it is this document which serves as basis for tenders by the (foreign) implementing bodies, and as a framework for them to carry out the next stage of the project cycle.

Stage (III) - Detailed Design:

This stage includes the translation of the project's conceptual design into blueprints and specifications for construction, facilities and equipments. Operating plans and work schedules are prepared and brought together in a formal implementation plan. The designers must bring together the views of policy and decision makers and technical experts in such a way that the design reflects the inputs of all those contributing to the project (Goodman and Love, 1980).

The outputs of this stage are approved blueprints for construction and approved specifications for equipment and hardware manufacture and installation.

Stage (IV) - Construction:

This stage includes the physical realisation of the elements that constitute the project, by using the standards, procedures and designs developed during the earlier stages. It involves such things as the setting up of the system, the fabrication of hardware, the construction of facilities and the allocation of authority and responsibility.

The output of this stage is the physical structure of the project, whereby facilities and equipments are in the "tested" state, i.e. they have been constructed and tested by the implementing organisations.

Stage (V) - Completion:

This stage represents the critical interface between the construction stage and the full operation of the project. It involves such things as: the acceptance of facilities and equipments by the operating organisation; the finalisation of supporting documentation; the final development of plans to support the project during its full operation phase; the evaluation of the adequacy of supporting systems; and evaluation of the technical and economic sufficiency to meet actual operating conditions.

The output of this stage is the actual integration of the project into the existing organisational systems, and its handover to the operating units in a "fully operational" state.

3.3.2 The Actors: As the project progresses through the stages outlined above, different organisational entities (from now on called "Actors") will play different roles in the decision-making process. Their roles will depend to a large extent on the responsibilities of these actors at each of the stages. The identification and analysis of the actors involved in a decision making situation will help to facilitate a better level of understanding of the situation and the underlying sets of values and judgements which drive these actors. This identification and analysis of actors has been adopted as an integral part of many systems methodologies. For example, the backbone of Checkland's methodology (Checkland, 1984) is the root definition of systems. He emphasised that a well-formed root definition should contain six elements, which can be remembered by the mnemonic CATWOE. The "A" in this mnemonic actually refers to actors whom he defined as:

"A person(s) who carries out one or more of the activities in the system."

Cleland & King (1983) and porter et al (1980) classify the identification and analysis of actors (sometimes referred to as stakeholders) as a crucial step in their problem structuring and specification phase.

The actors have been identified and classified in many ways, usually depending on the general setting of the decision situation. Porter et al (1980) classified the actors in a technological innovation and development setting as:

Designers

Implementors

Users

Regulators.

Cleland & King (1983) classified the stakeholders, who have a stake in the activities and future of a business firm as:

Stockholders

Creditors

Employees

Customers

Suppliers

Governments

Unions

Competitors

Local communities

The general public.

They also emphasised that, to apply the systems approach in management, these stakeholders must be identified and the nature of their claim (on the system) specified. Eldin & Avots (1978) outlined the typical project environment of large development projects, they identified the clientele involved as the project moves from initiation to completion. These clientele and their relationships are shown in Fig 3.2.

However, all the above classifications of relevant actors were formulated for the sake of analysis and understanding of the complex systems involved. But when it comes to decision making, all the above methodologies have assumed that it is performed by a single entity achieving consensus among its constituent parts; if necessary, by adopting decision aids such as the Delphi Technique and Brainstorming. This is not only true for the above methodologies but also for most, if not all, other proposed decision making methodologies, models and methods (Hwang & Yoon, 1981).

The novel approach proposed here is based on the proposition that: the decision making body of large development projects should not be regarded as a



Aston University

Illustration has been removed for copyright restrictions

Source: Eldin, H.K. & I. Avots (1978): Guidelines for Successful Management of Projects in the Middle East: The Client Point of View; Proceedings of the Project Management Institute, 10th Annual Symposium, Los Angeles, October 1978. Reproduced in Cleland & King (1983).

Fig 3.2: Typical Clientele Influencing the Management of Large Development Projects

single entity but as a constituent body of distinct and diverse actors; each of these actors holding distinct objectives, goals and concerns; and that consensus among these actors may be unattainable, hence decisions may have to be taken in spite of the actors' differences.

In the case of large development projects executed within the specified context, the relevant actors in the decision making process, classified according to their roles and responsibilities during the project life cycle, are as follows:

Operators: They are the people who will receive and operate the project upon its completion. They could be either part of an ongoing organisation, whereupon the new project will form an extension of their present responsibilities, or a new organisation especially formed to receive and operate the project.

Implementors: They are the people responsible for the physical construction of the project, who are usually responsible for the stages of "detailed design" and "construction" (including testing and commissioning).

They could be formed into either an ad-hoc unit, internal to the organisation, to implement a project or series of projects, or, a permanent unit, internal to the organisation, whose responsibility is confined to project implementation and management. However, as mentioned earlier, for large technological projects, the Implementors are usually foreign contractors contracted and supervised by national project organisations acting on behalf of the operating organisations.

Planners: They are the people responsible for the "formulation" and "conceptual design" stages of the project; they are also responsible for the interpretation of the organisational attitudes, aims and policies during all the stages of the project up to the operation stage.

These again could be either an ad-hoc team set up especially to carry out a certain project and then disbanded; or, a permanent set-up devoted to the "formulation" and "conceptual design" of projects, and to the interpretation of the operating organisation's goals, objectives and policies during their implementation. They could be either a small team coordinating the activities of consultants who carry out these responsibilities on their behalf, or a large set up where there is enough in-house ability to carry them out themselves.

Arbiters (A): The Oxford English Dictionary defines arbiters as:

"Persons who have the power to decide what shall be done or accepted, ones with entire control."

In the real world, and for every decision situation, there must be a person or persons who can display final authority and control. Obviously, these persons will vary according to the decision situations and depending on the established patterns and forms of authorities, responsibilities and accountabilities.

In this context, the Arbiters are referred to as the person(s) who, while not necessarily involved in the day-to-day planning and implementation of projects, are the one(s) who can be consulted about, and who are capable of taking a decision on, a situation which is contentious between the Operators, Implementors and Planners. They can be regarded as the ultimate expressers of the organisational goals and policies, as they are relevant to a particular decision situation.

The above classification of actors represents a reflection of their roles during the project life cycle. It does not mean that they always represent different people in the decision making process. Since the same person(s) could change from one role to another, as the project passes through its stages, or due to the differing decision situations that have to be dealt with in a particular stage.

These actors have different (multiple) objectives and goals, and each of

them would like his objectives and goals to be the basis for decisions in the project life cycle.

This diversity in goals and objectives may be explained by relating the responsibilities of these actors to the stages that constitute the project life cycle.

3.4 RESPONSIBILITIES, OBJECTIVES AND DECISION MAKING

The concept of "responsibility" of the principal actors, as related to the stages of the project life cycle, has been tackled in various ways. Goodman & Love (1980) considered it as taking one of the following forms:

- (1) Major policy responsibilities
- (2) Major operating responsibilities
- (3) Related cooperative or regulatory responsibilities.

Cleland & King (1983) adopted the following categorisation of responsibility, in their outline of the linear responsibility chart (LRC), in the development of an industrial system:

- (1) Primary responsibility
- (2) Support responsibility
- (3) Notification
- (4) Approval authority
- (5) Occasional notification.

Eldin & Avots (1978) constructed a responsibility matrix for the typical project environment of a large development project. They classified the responsibilities of the bodies involved as:

- (1) Ultimate responsibility
- (2) Assigned to project
- (3) Peripheral activities.

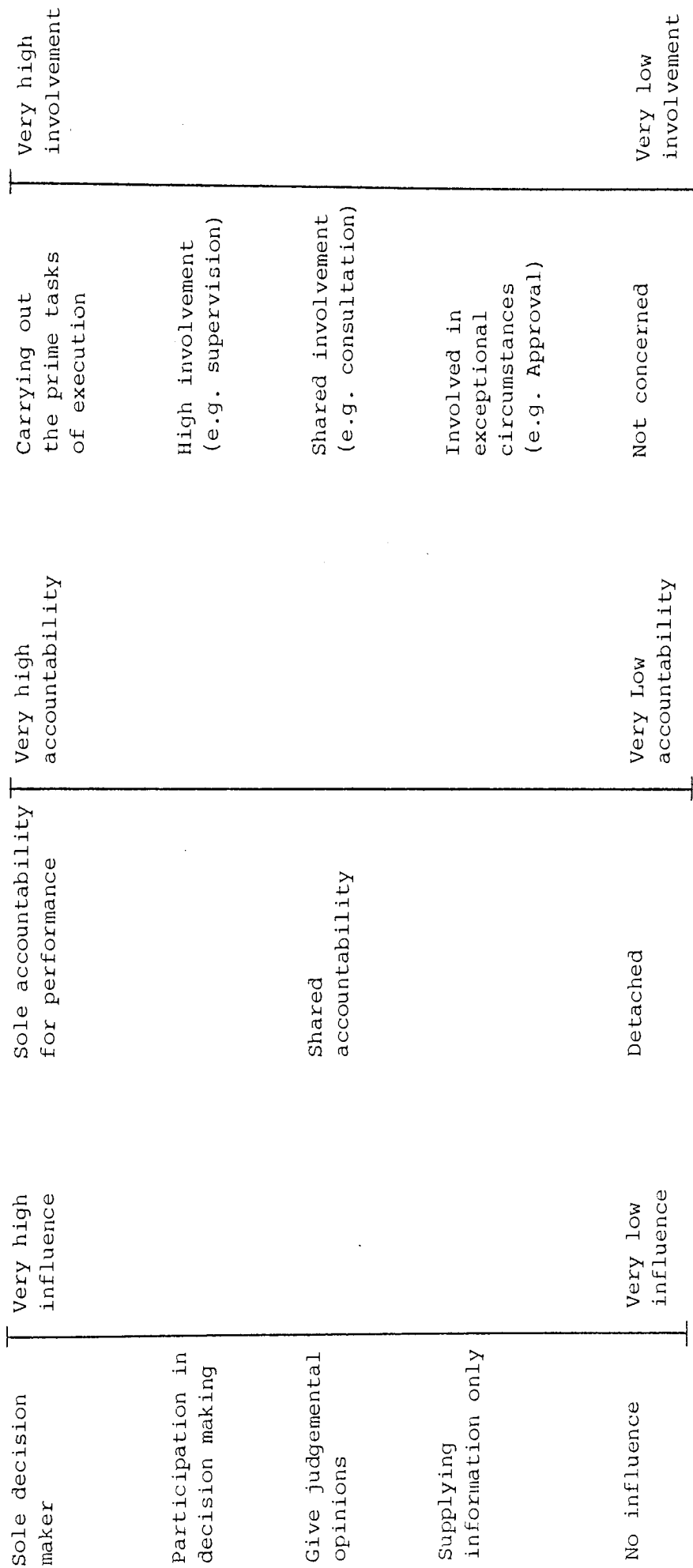
It is felt that none of the above classifications adequately reflect the responsibilities of the actors and their roles in the decision making process as the

project moves through its stages, and that the reflection of responsibilities requires more complex scales and instruments. Therefore, it is suggested, that the concept of "responsibility" may be interpreted as a combination of the following dimensions (or components):

- (a) Influence: This component, which reflects the influence of the actor on a decision, could be measured by an ordinal scale as shown in Fig 3.3 a.
- (b) Accountability: This component, which reflects the extent to which the actor is held responsible for the system performance when it deviates from anticipated levels, could be measured on the scale shown in Fig 3.3 b.
- (c) Involvement: This component, which reflects the degree of participation of the actor in the day-to-day management and actions, could be measured on the scale shown in Fig 3.3 c.

The "responsibility" of an actor is an ordinal measure which should reflect the implicit combinations of the above components. Taking the definitions of the roles of the actors outlined in section 3.3.2, and relating these definitions to the context of technological development projects, the responsibility of each of the actors, at each stage, can be deduced by determining the level of each of the components on their respective scales. Fig 3.4 shows the typical responsibility matrix, for the actors, at the "detailed design" stage of the development project cycle.

The same procedure could be repeated to determine the responsibility matrix for each stage of the project cycle. These matrices could then be



a. Influence Scale

b. Accountability Scale

c. Involvement Scale

Fig 3.3: Scales of "Responsibility" Components (suggested)

| ACTORS COMPONENTS | ARBITERS (A) | PLANNERS (P) | IMPLEMENTORS (I) | OPERATORS (O) |
|----------------------|--|--|---|-----------------------------------|
| INFLUENCE | Major when called upon otherwise (LOW) | Major influence (HIGH) | Major influence (HIGH) | Information and opinions (LOW) |
| ACCOUNTABILITY | Although ultimately accountable, but in reality (LOW) | (HIGH) | (HIGH) | (VERY LOW) |
| INVOLVEMENT | Exceptional circumstances only (LOW) | Supervision and consultation (HIGH) | The principal executives (VERY HIGH) | Some consultation (LOW) |
| RESPONSIBILITY | (LOW) | (HIGH) | (VERY HIGH) | (VERY LOW) |

Fig 3.4: Detailed Stage Responsibility Matrix for the Principal Actors at the Stage of "Detailed Design" of a Typical Large Development Project

integrated into one overall responsibility matrix for the whole project, where the rows of this matrix represent the stages and the columns the actors, and the cells denote the extent of overall responsibility of that actor at that particular stage; Fig 3.5 shows a typical overall responsibility matrix of a large technological development project.

It is proposed here that: the actors' objectives are directly derived from their pursuit of self development, prestige, status, rewards, etc.; the achievements of these objectives are directly related to the degree the actors are perceived to carry their responsibilities and how well they carry them out (as measured by indices laid out for this purpose in the particular organisation); and the diversity in responsibilities among the actors, as related to the project stages, will manifest itself in the diversification of their objectives and hence, on their attitudes and values when faced with decision situations. In other words, the actor responsibility profile, as reflected in the overall responsibility matrix will have a direct bearing upon determining the issues that concern him/her and the range of criteria that govern his/her attitudes to any decision situation.

Hence, the Operators' domain of objectives will be restricted to issues which are paramount in the operating stage (e.g. safety, maintenance, operating costs), while the Planners' field of consideration will be restricted to such issues as:

- completion time of the project.
- To be within the allocated budget.
- Performance objectives being achieved upon completion.

(Note that Cleland & King (1983) treated the above objectives as being normative for the whole project management system and not just for the Planners as advanced here. This reflects the reductionist tendencies in the classical systems analysts approach.)

Table 3.4 shows an outline of the expected objectives of the principal

LEGEND : V.L - Very Low
 L - Low
 M - Medium
 H - High
 V.H - Very High

| ACTORS STAGES | ARBITERS (A) | PLANNERS (P) | IMPLEMENTORS (I) | OPERATORS (O) |
|------------------|-----------------|-----------------|---------------------|------------------|
| | STAGE (I) | H | H | V.L |
| STAGE (II) | M | V.H | V.L | V.L |
| STAGE (III) | L | H | V.H | V.L |
| STAGE (IV) | L | L | V.H | M |
| STAGE (V) | L | V.L | H | H |

Fig 3.5: Overall Responsibility Matrix for the Principal Actors in a Typical Cycle of Large Technological Development Projects

actors, based on their responsibility profiles as shown in Fig 3.5.

This diversity of objectives among the actors will ensure that decision situations confronted during the project cycle will, by necessity, be of the multi-criteria type, since each actor will evaluate the situation according to his/her (explicit and implicit) set of criteria and values and the relative importance he/she attaches to each criterion. In addition, the participation of the principal actors will ensure that the criteria which have relevant impact during the whole life cycle of the project will be considered and not just the criteria that are paramount during the project's early stages, as it is usually the case.

However, the integrative consideration of these multiple criteria by the actors, requires methods, procedures and techniques to ensure that the actors' preferences and judgements are accurately reflected and properly operationalised. These methods, procedures and techniques should be in accordance, as much as possible, with the actors' natural decision making behaviour and tendencies. To determine the appropriate methods and techniques, it is necessary to review the field of multiple criteria decision making. This is the subject of the next chapter.

| ACTORS | STAGES OF MAIN RESPONSIBILITY (V.H) & (H) IN FIG 3.5 | MAIN OBJECTIVES AND AIMS |
|---------------------|--|---|
| ARBITERS (A) | I | Ensuring that the project is carried out in accordance with the organisation's aims, goals, ethos and policies |
| PLANNERS (P) | I, II & III | Effective completion of the project within the established constraints and policies |
| IMPLEMENTORS (I) | III, IV & V | Pursuance of the implementing organisation's own objectives of viability and development |
| OPERATORS (O) | V | Smooth take over of the project; with the prior availability and capability of the required resources and systems |

Table 3.4: Presumed Objectives of the Actors Involved in the Planning and Implementing Process of Technological Projects

CHAPTER 4

MULTIPLE CRITERIA DECISION MAKING -

AN OVERVIEW

4.1 INTRODUCTION

This chapter is devoted to the review of research and literature in the field of Multiple Criteria Decision Making (MCDM). There have been many excellent reviews of MCDM methods and models (e.g. Farquhar, 1980; Fishburn, 1977; Keeney & Raiffa, 1976; Moskowitz & Wright, 1979; Hwang & Yoon, 1981), however, these methods and models are reviewed here to ascertain their relative merit to deal with decision situations in the context of technological development projects outlined in chapters 2 and 3.

Section 2 will formally outline the general decision situation, its general characteristics and its main elements. This general situation will assume that the decision makers form a single homogenous entity.

Section 3 will be devoted to the review of the models and methods of MCDM. These are classified according to their strategy in approaching the decision situation and aiding decision making.

Section 4 will be devoted to the review of the principal issues that arise in any MCDM situation, and have direct bearing on the effectiveness of the above methods and the ability of the decision makers to make enlightened decisions. These issues concern; decision makers and their behaviour individually and in a group; alternatives generation; and criteria selection.

The chapter ends (section 5) with an outline of the basic principles that underly an effective decision making methodology suitable for the specified context and decision making system of large development projects. These principles are deduced directly from the review of methods, models and issues involved in MCDM.

4.2 THE GENERAL DECISION SITUATION

MCDM refers to making decisions in the presence of multiple, usually conflicting, criteria. In general, the decision situations encountered in the

context of large technological development projects are widely diverse, however, even with this diversity, all these situations can be assumed to share the following common characteristics:

(1) Multiple Criteria: Each situation has multiple measures of effectiveness (criteria) where these measures may emerge as a form of attributes or objectives in the actual decision situations; "attributes" are treated here as synonymous with performance parameters, characteristics and properties. They should provide a means of evaluating the levels of achievements of objectives. Hence, each alternative can be characterised by a number of attributes. "Objectives" are something which are to be pursued to their fullest and they generally indicate the direction of change desired (Hwang & Yoon, 1981).

(2) Conflict Among Criteria: Multiple criteria usually conflict with each other. Hence, there is no optimal solution to a MCDM situation (an optimal solution is one which results in a maximum/minimum value for each criteria simultaneously).

(3) Incommensurable Units: Each quantitative criterion has a different unit of measurement, e.g. "cost" in monetary units; "safety" in number injured/year. (Qualitative criteria are expressed differently e.g. high/low flexibility).

(4) Selection Driven: The purpose of any MCDM situation is taken to be the selection of the best alternative among previously specified alternatives. The process involves searching for an alternative that is the most attractive over all the criteria. Therefore the focus here is on what has been termed as MADM (Multi-Attribute-Decision-Making), as opposed to MODM (Multi-Objective-

Decision- Making) where the thrust is to design the best alternative by considering the various interactions within the design constraints (this classification has been proposed by many authors such as Cohon, 1978; Hwang & Masud, 1979).

Hence, the general decision situation is taken to be one that has a limited number of predetermined alternatives. The alternatives have associated with them levels of achievement of the criteria (which may not necessarily be quantifiable), and that based on these values the final selection of the alternative is to be made. The selection is made with the help of inter and intra-criteria comparisons. The comparisons may involve explicit or implicit tradeoffs.

This general decision situation may be concisely expressed in a matrix format. The resultant decision matrix (D) is a (m x n) matrix whose elements x_{ij} indicate the level of achievement of alternative (A_i), with respect to criterion (X_j). Hence, the alternative (A_i) is denoted by a vector such that:

$$\text{Alternative (A}_i\text{) vector} = (x_{i1}, x_{i2}, \dots x_{in})$$

$$\text{where } i = 1, 2, \dots m$$

and the criterion (X_j) is denoted by a vector such that

$$\text{Criterion (X}_j\text{) vector} = (x_{1j}, x_{2j}, \dots x_{mj})^T$$

The decision matrix (D) is shown in Fig 4.1. This matrix will be taken as the basic structure of the decision situation according to which the various methods, techniques and approaches of MCDM will be reviewed.

Also, it will be assumed throughout the review of these methods, that the decision maker is (Cleland & King, 1983):

"An entity, either individual or group, who is dissatisfied with some existing state or with the prospect of a future state and who possesses the desire and authority to initiate actions designed to alter this state."

| CRITERIA ALTERNATIVES | | j = 1, 2, 3 - - - - n | | | | | | | |
|--|--------------------------------------|-----------------------|-----------------|-----------------|-----------|-----------------|------------------------------------|-----------------|--|
| | | x ₁ | x ₂ | x ₃ | - - - - - | x _j | - - - - - | x _n | |
| m - - - - - 1, 2 - - - - - i - - - - - m | A ₁ | x ₁₁ | x ₁₂ | x ₁₃ | | x _{1j} | Criterion (x _j) Vector | x _{1n} | |
| | A ₂ | x ₂₁ | x ₂₂ | x ₂₃ | | x _{2j} | | x _{2n} | |
| | A ₃ | x ₃₁ | x ₃₂ | x ₃₃ | | x _{3j} | | x _{3n} | |
| | Alternative (A _i) Vector | | | | | | | | |
| | A _i | x _{i1} | x _{i2} | x _{i3} | | x _{ij} | | x _{in} | |
| | A _m | x _{m1} | x _{m2} | x _{m3} | | x _{mj} | x _{mn} | | |

No. of relevant criteria = n

No. of identified alternatives = m

Fig 4.1: Outline of Decision Matrix (D)

4.3 THE METHODS OF MCDM

The methods of MCDM have been classified in many ways; Hwang & Yoon (1981) classified the methods according to the type of preference information demanded from the decision maker; Pettigrew (1973) claimed that the most widely accepted forms of classification are mathematical - economic and behavioural, a classification followed to a large extent by French (1982) in his survey; Moskowitz & Wright (1979) classified the methods, according to their intra-attribute comparison approach, as "compensatory" and "non-compensatory". In the following review of these methods, it is thought appropriate to classify them according to their principal strategy in approaching the multiple criteria situations and in aiding decision making. Hence, the classification is as follows:

- The Filtering stream
- The Reductionist stream
- The Programming stream
- The Pairwise-Comparison stream
- The Behavioural stream.

These streams will be reviewed in turn, with particular emphasis on the evaluation of the various methods as to; their simplicity in use; usefulness in actual decision making; attitudes of the decision makers to their demands; and the role they are best suited for. The methods will be reviewed according to the general decision situation outlined in Fig 4.1.

4.3.1 The Filtering Stream: This stream covers methods that involve no tradeoffs between criteria and in which each criterion must stand on its own (i.e. non-compensatory (Hwang & Yoon, 1981)). Hence, comparisons are made on criterion-by-criterion basis. They are usually advocated for their simplicity and their matching with the behaviour process of the decision maker whose knowledge

and ability are limited (Hwang & Yoon, 1981).

Methods covered by this stream include Dominance, Maximin, Maximax, Conjunctive and Disjunctive.

Dominance is a general concept in MCDM, it stipulates that an alternative is regarded as dominated if there is another alternative which exceeds it in one or more criteria and equals it in the remainder. This method does not require additional assumptions or any transformation of criteria. The usual procedure followed is that: two alternatives are compared at a time and the dominated alternative is discarded (Calpine & Holding, 1976). The non-dominated set usually has multiple elements in it, hence this method is mainly used for initial filtering of the alternatives (Terry, 1963).

Formally, alternative A_i dominates alternative A_k iff:

$$\begin{array}{ll} x_{ij} > x_{kj} & \text{for at least one } j \\ \text{And } x_{ij} \geq x_{kj} & \text{for the remaining } j\text{'s.} \end{array}$$

Maximin procedure involves the selection of the maximum (across alternatives) of the minimum (across criteria) values, or the "maximin". Under this procedure only a single weakest criterion represents an alternative; all other (n-1) criteria of a particular alternative are ignored. These lowest values usually come from different criteria, hence, the criteria must be measured on a common scale (they don't have to be numerical).

Formally, the alternative A^+ , is selected such that:

$$A^+ = \left\{ A_i \mid \max_i \min_j x_{ij} \right\} \quad \begin{array}{l} j = 1 \text{ ---- } n \\ i = 1 \text{ ---- } m \end{array}$$

where all x_{ij} 's are measured on a common scale.

Note: There are many methods of transforming the criteria to a common scale; one way is by using the degree of closeness to the ideal values (Zeleny,

1974), by taking the ratio of the criterion value (x_{ij}) to the most preferable criterion value (x_j^{\max}), that is:

$$r_{ij} = \frac{x_{ij}}{x_j^{\max}}$$

A more complicated form of r_{ij} (Hwang & Yoon, 1981) is:

$$r_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}}$$

where $x_j^{\max} = \max_i x_{ij}$ $i = 1 \text{ --- } m$

& $x_j^{\min} = \min_i x_{ij}$

(This second procedure has the advantage that the scale of measurement, for each criterion, varies precisely from 0 to 1).

Then, the procedure will formally become:

$$A^+ = \left\{ A_i \mid \max_i \min_j r_{ij} \right\}$$

This method utilizes only a small part of the available information in making a final choice, and by concentrating on only the minimum values of the criteria, it would only be reasonable to use it if the decision maker is assumed to be pessimistic.

Maximax procedure involves the selection of the alternative that has the maximum of the largest criteria values. Therefore, it is ultra-optimistic, in that it describes the decision maker as choosing the alternative for which the best criterion value is the best among the alternatives.

Formally, the alternative A^+ is chosen such that

$$A^+ = \left\{ A_i \mid \max_i \max_j r_{ij} \right\}$$

where $r_{ij} =$ the common scale value of x_{ij} (see maximin above).

Conjunctive procedure, sometimes called the satisficing method, involves the rejection of all alternatives that have a criterion value less than a prescribed level, i.e. in this method all the standards must be passed in order for the alternatives to be acceptable (Hwang & Yoon, 1981).

To apply the method, the decision maker must supply the minimal criteria values (the cut off values) acceptable for each criterion. These cut off values play the key role in eliminating the unsuitable alternatives; if they are set too high, none of the alternatives will pass; if relatively low, quite a few alternatives will be left after filtering. Hence, the method could be used iteratively.

Formally, (A_i) is an acceptable alternative iff:

$$x_{ij} > x_j^0 \quad j = 1, 2, \dots, n$$

where x_j^0 is the cut off level of x_{ij} .

The conjunctive method is not usually used for the selection of alternatives but rather for classifying them into acceptable/not acceptable categories (Dawes, 1964)).

Disjunctive procedure involves the selection of alternatives which have their greatest criteria values above a certain desirable level.

Formally, (A_i) is an acceptable alternative iff:

$$x_{ij} \geq x_j^0 \quad j = 1 \text{ or } 2 \dots \text{ or } n$$

where x_j^0 is a desirable level of x_j .

Hence, this method guarantees the selection of alternatives with an extreme criteria value (Hwang & Yoon, 1981; Dawes, 1964).

All the above methods are easy to justify and do not involve reliance on relative weights, trade-off functions, or other numerical computations. Hence, they are usually preferred by the decision makers, to other methods (Slovic et al

1977). Behavioural theorists have indicated that decision makers use many rules and strategies en route to a decision, these include conjunctive, disjunctive and the principle of dominance. They also stressed that early in the process, decision makers tend to compare a number of alternatives on the same criteria and use conjunctive rules to reject some alternatives from further consideration (Sheridan et al, 1975; Slovic et al, 1977), and that only later, that they appear to employ compensatory weighing of advantages and disadvantages on the reduced set of alternatives. They speculated that the motive for the use of the above methods is to reduce the strain of decision making in situations that involve incomplete data, incommensurable dimensions, time pressures and information overload (Slovic & Lichtenstein, 1971; Wright, 1974).

4.3.2 The Reductionist Stream: This stream covers methods that involves the reduction of the multi-dimensional representation of an alternative to a single number, whereby the evaluation of the alternative will be based on the relative value of this number compared to other alternatives.

The principal methods covered by this stream are Cost-Benefit-Analysis (C.B.A.); Criteria trade-off; and Multi-Attribute Utility Theory (M.A.U.T.).

Cost-Benefit- Analysis (C.B.A.) incorporates a broad array of loosely structured economic analysis techniques in a common framework (Porter et al, 1980). The C.B.A. method has been explained in detail in economic development books (e.g. Mishan, 1976; Little & Mirrlees, 1976; Sassone & Schaffer, 1978). Its basic idea is to use shadow rather than actual prices when evaluating the impacts of alternatives on the criteria; whereby all the impact values (x_{ij} s) will be calculated according to a system of shadow prices, and will be represented by their equivalent monetary values. These impacts are divided into "costs" and "benefits" and their time stream values are often discounted using a "social



discount rate". Hence, all the "costs" and "benefits" will be reduced to a single number, and the selection of an alternative will be made according to one of the familiar economic criteria (highest net present value (NPV); highest benefit/cost ratio; etc).

Although, the use of C.B.A. has been advocated vigorously, especially for the evaluation of projects in the public sector (Porter et al, 1980; Friend & Jessop, 1976) and for developing countries (Little & Mirrlees, 1976; Tinbergen, 1967), mainly to ensure a wider focus and the proper consideration of external effects, serious doubts have been raised about its appropriateness; Kadhim (1974) highlighted the difficulties involved in identifying the relevant criteria and the scope of the analysis in the developing context; Lovins (1977) suggested that analysts may vary the discount rate to justify the programs they favour; and Porter et al (1980), although conceded its usefulness, gave the following warning:

"The major point to be made is that quantitative C.B.A. results should not be the sole criterion on which a project is made."

Stern (1976) warned against the use of C.B.A. for sophisticated self interest and prejudices, and questioned the motives behind the famous C.B.A. study commissioned by the Roskill Commission to choose the site of London's third international airport (Flowerdew et al, 1972) he, Stern, actually warned that the covert reason for cost benefit analysis may be

"Scientifically justifying unpopular decisions for the sake of the few."

He also indicated that analysts tend to choose factors and criteria that yield to costing and conversion to monetary values and to neglect factors that are difficult to measure and quantify.

The Criteria Trade-off method facilitates alternative choice by making the alternatives equivalent for all criteria except one by trade-offs, and then evaluate the alternatives by the values of the remaining one (Hwang & Yoon,

1981). A trade-off is simply a statement of how much of one criterion the decision maker would be willing to give up in order to obtain a specified gain in some other criterion and vice versa. This trade-off could be facilitated by direct questioning (Moskowitz & Wright, 1979) or by the use of indifference curves (Hwang & Yoon, 1981).

This process of making trade-offs is straightforward, conceptually simple and applies to the case of uncertainty as well as certainty. It provides a useful means of evaluating several distinct alternatives that have multiple criteria, and it does not require any prior assumptions about the responses of the decision makers. All that is required is that at least one criterion be measurable on a continuous scale e.g. dollars. But the method can be tedious and time consuming particularly if the situation involves many criteria and alternatives (Moskowitz & Wright, 1979).

Multi-Attribute Utility Theory (MAUT) provides a procedure for prescriptively modelling the decision maker's trade-offs between conflicting objectives, where uncertainty of outcome exists (Keeney & Raiffa, 1976). [Note: In case of certainty of outcomes it is called Multi-Attribute Value Theory (MAVT) (French, 1983)].

The theory prescribes that for every alternative (A_i), a composite utility value is computed ($U(A_i)$), such that

$$U(A_i) = \sum_{j=1}^n W_j U(x_{ij})$$

Where (W_j) is the relative importance of the j^{th} criterion and $U(x_{ij})$ is the utility (value) of the i^{th} alternative on the j^{th} criterion. Hence, each alternative will be represented by a single value representing its composite utility, and selections will be made according to these utility values.

The above simple additive model is the best known and most widely used of all MAU models (Hwang & Yoon, 1981; Moskowitz & Wright, 1979) that is because of its simplicity and intuitive appeal. Other nonlinear models have been derived when the criteria in question are complementary (that is, excellence in one criterion enhances the utility of excellence with respect to another); or substitutes (that is, excellence with respect to one criterion reduces the utility gain associated with excellence with respect to other criteria), whereby it is hard to expect that criteria take the separable additive form. In these cases, the overall utility score can be made in multiplicative or multilinear form (basic theoretical matters are discussed by Fishburn (1965); Fishburn & Keeney (1974) and Keeney & Raiffa (1976)). But, theory, simulation and experience all suggest that the simple additive weighting model yields extremely close approximations to very much more complicated and nonlinear forms, while remaining far easier to use and to understand (Hwang & Yoon, 1979; Edwards, 1977).

The weights (W_j)s and utilities $U(x_{ij})$ s may be assessed directly or indirectly. Direct approaches, which are simple but not theoretically justified (Slovic, et al, 1977), include ranking or rating scales, or just asking the assessors for the relevant numbers, remembering always that the utilities $U(x_{ij})$ s must be both numerical and comparable, and that the weights are formed according to reasonable bases reflecting the relative importance of the criteria. These simple methods of assessments have been recommended by many authors (e.g. Cleland & King, 1983; Kepner & Tregoe, 1981). The utilities $U(x_{ij})$ s may be assessed directly by constructing a utility curve for the decision maker (Moskowitz & Wright, 1979) or, by constructing indifference curves for pairs of criteria (MacCrimmon & Sui, 1974; Moskowitz & Wright, 1979), but these methods are lengthy and impractical when there are many criteria involved. Indirect methods for assessing utilities and weights, are more complex and they rely mainly on comparison between a gamble and a sure thing (certainty equivalent) and thus

introduce probabilities which are used to derive the values of weights and utilities (Moskowitz & Wright (1979) give a good review of these methods). However these methods are usually unacceptable to decision makers when the criteria involved are more than two. To overcome this, Keeney (1972) has proposed a method that takes one criterion at a time and assesses its utility function (using any one of the above methods) and showed how these single utility functions may be combined, either additively or multiplicatively, to produce the overall utility functions of the alternative. He used his method extensively in such real application as selecting a location for Mexico City airport (De-Neufville & Keeney, 1972) and the evaluation of sites for water storage (Keeney, 1979). His method is fully explained in Keeney & Raiffa (1976).

Having computed the utility value $U(A_i)$ for each alternative, the remaining question is how to determine the preferred alternative. If all the alternatives are certain to occur, or if the probability of their occurrence is the same, then the alternative with the highest utility value should be preferred. However, if the probabilities of occurrence are not the same, then, according to the normative risk theory, the alternative yielding the highest expected utility should be chosen; where expected utility for each alternative is computed by multiplying its utility by its probability (Moskowitz & Wright, 1979). The normative theory assumes that people behave to maximise the utility-probability product and that it is rational to so behave (Slovic et al, 1977; Keeney, 1972). These assumptions have been criticised by many authors. MacCrimmon (1968) and Coombs (1975) have argued that risky choice is determined not by maximum expected utility, but by a compromise between maximization of value and optimization of risk. Tversky & Kahneman (1975) presented evidence that decision makers violate the maximum expected utility theory. They attributed this to the; "certainty effect" which causes consequences that are obtained with certainty to be valued more than uncertain consequences; and the "reference effect" which leads decision

makers to evaluate alternatives relative to a reference point corresponding to their status quo, adaptation level, or expectation, hence by altering the reference point, formally equivalent versions of the same decision problem may elicit different preferences. They concluded that these effects pose serious problems for the normative theory and its application.

4.3.3 The Programming Stream: This stream covers mathematical programming methods and models which utilize the techniques and algorithms of linear programming (LP) to solve problems involving multiple criteria. These models are especially suitable for the Multiple-Objectives-Decision-Making (MODM) type of situations that are geared towards finding the alternatives with the best achievement values on the criteria (i.e. design problems) as opposed to selection of the best alternative among a known and limited set (i.e. selection problems). The most significant of these models are goal programming and interactive multi-objective programming.

Goal Programming (GP) is an extension of linear programming, as it allows for a simultaneous solution of a system of complex objectives rather than a single objective (Anderson & Earle, 1983). It avoids the traditional problem of translating of incommensurable goal measurements into common benefit or utility measurement by allowing goals to be measured in unlike units through the creation of a multidimensional objective function (Taylor et al, 1983).

In goal programming, the decision maker specifies acceptable or desired levels on the criteria values, and these serve as the primary goal, he also provides the ranking of the goals indicating their importance. Goal programming finds a solution which is the nearest to the goals such that a lower rank goal is never satisfied to the detriment of the satisfaction of a higher rank goal (Masud & Hwang, 1981); this is done by minimizing the deviations between goals and what

can be achieved within the given set of constraints (Lee & Clayton, 1972). In the simplex algorithm of linear programming, such deviations are called "slack" variables, and each of these deviational variables is represented in two directions; for positive and negative deviation from each goal or subgoal. Then, the objective function becomes the minimization of these deviations, based on their relative importance or preemptive priority weights assigned to them (Lee & Clayton, 1972; Moskowitz & Wright, 1979) i.e. goals are satisfied in an ordinal sequence.

The model's basic objective is to search for an optimal result which allows for the maximization of goal attainment, hence the formulation of the objective function and constraints must be done carefully and critically to ensure the best result for decision making (Kahalas & Gray, 1976).

The GP models are simple and intuitively appealing, the information demand from the decision makers is not excessive and available solution algorithm may be adapted easily for their solution (Masud & Hwang, 1981). However, some authors such as Zeleny & Cochrane (1978) and Zeleny (1980) have criticised the procedure on the basis that a priori specification of goals and their ranks can result in a solution which may not be "non dominated". But, these criticisms are inappropriate since there is no rule preventing the decision makers from repeating the procedure until they are satisfied with the solution. Indeed some authors (e.g. Taylor, 1983) have recommended that sensitivity analysis should be performed (by making changes in the priority structure, the desired goals or the technological coefficients) to provide the decision makers with additional insights on the model and the effect of input alterations on the output.

Interactive Multi-Objective Programming is a further development on LP & GP (see MacCrimmon, 1973 and Zeleny, 1974 for full details). It basically relies on an interactive dialogue with the decision maker while exploring the feasible

solution space. At each such dialogue (decision maker-analyst or decision maker-machine), the decision maker is asked about preference information based upon the current solution (or the set of the current solutions) in order to determine a more preferred solution (Masud & Hwang, 1981). This process is repeated until a solution is obtained, such that the decision maker would feel satisfied with and ready to accept (French, 1983).

The advantages of an interactive approach are that; it provides for the decision makers a learning process about the system by making an allowance for their psychological convergence (Masud & Hwang, 1981); it does not ask the decision makers hypothetical questions, and their preferences are made between real alternatives; and the decision makers judgements and preferences are made holistically with no analysis of components preferences (Zeleny, 1974).

The principal foundation of the interactive approach is that choice is a Gestalt process in which alternatives are considered holistically (Goicoechea et al, 1982; Duckstein, 1975), however, French (1983) quoted extensive behavioural evidence that when decision makers are faced with multidimensional situations, they resort to very poor heuristics and he argued that empirical research did not support the underlying assumptions of interactive programming. He also dismissed the value of any decision aid which wholly concentrates on the problem, by stating that:

"A good decision aid should help the decision maker explore not just the problem, but also himself."

4.3.4 The Pairwise - Comparison Stream This stream covers the methods that base alternatives selection on the construction of a ranked set of the alternatives based on their relative achievements of an overall objective or a focus, and where the ranking is achieved by intra-criteria pairwise comparisons without criteria substitutions, trade off or unit conversions.

The principal methods covered by this stream are:

- Interpretive structural modelling (ISM)
- Analytical hierarchy process (AHP)
- Ideal proximity models.

Interpretive Structural Modelling (ISM) is a relatively simple technique that is useful in the structuring and definition of decision problems (Porter et al, 1980), it helps to identify structure within a system of related elements.

The structural modelling starts with the identification of the overall focus of the decision problem; which is the overall goal that the system is striving to achieve. Then, the alternatives are compared pairwise, according to a "relational statement", which relates the overall focus to the alternatives. A code is adopted to express the comparison between the alternatives; 'yes' or '1' to express agreement with the relational statement and 'no' or '0' to express disagreement. The overall ranking of the alternatives may then be deduced either by a diagraph (directed graph), which is a set of alternatives connected by arrows, or by a matrix of ones and zeros.

ISM is a qualitative, not a quantitative technique; and its attractiveness lies in its simple structure and easy logic. But, due to its dependence on wholistic comparisons between alternatives and the limitation of its comparison codes and scales, its usefulness will be limited to the early stages of problem structuring and mainly to alternatives identification and screening (Porter et al, 1980; Sage, 1977).

The Analytical Hierarchy Process (AHP), formulated by Saaty (1977a) and explained fully in his book (Saaty, 1980), may be divided into three major components:

- (1) Decomposing a problem (usually complex) into a hierarchy, where

each level of this hierarchy consists of a few manageable elements and each element in turn is decomposed into another set of elements. The process continues down to the most specific elements of the problem, typically the alternative courses of actions considered, which are represented at the lowest level of the hierarchy. Wind & Saaty (1980) have justified the usefulness of the hierarchical decomposition. Thus:


"Structuring any decision problem hierarchically is an efficient way of dealing with complexity and identifying the major components of the problem."

The simplest hierarchy is a two level hierarchy, these levels are usually:


- Alternatives
- Criteria for evaluation of the alternatives.

(2) A measurement methodology, which is used to establish priorities among the elements within each stratum of the hierarchy. This is accomplished by asking the participants to evaluate each set of elements (e.g. alternatives), in a pairwise fashion, with respect to each of the elements in a higher stratum (e.g. criteria). Hence, the hierarchy is broken down into a series of pairwise comparison matrices, and the decision makers are asked to evaluate the off-diagonal relationships in one half of each matrix (reciprocals are placed in the transposed positions). Fig 4.2 illustrates a general two level hierarchy and a schematic of a pairwise-comparison matrix.

To provide a numerical judgement in making pairwise comparisons, a 1-9 scale is adopted (table 4.1 illustrates the scale). Saaty (1980) justified the use of this scale, thus:



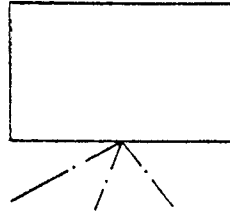
Aston University



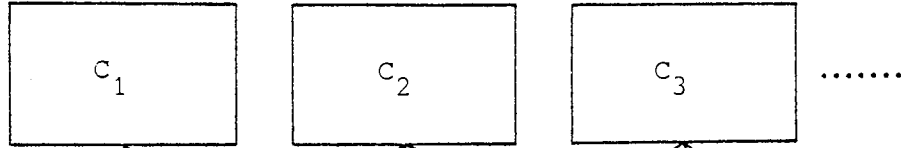
Aston University

Content has been removed for copyright reasons

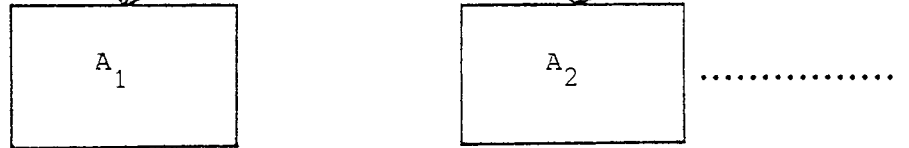
FOCUS



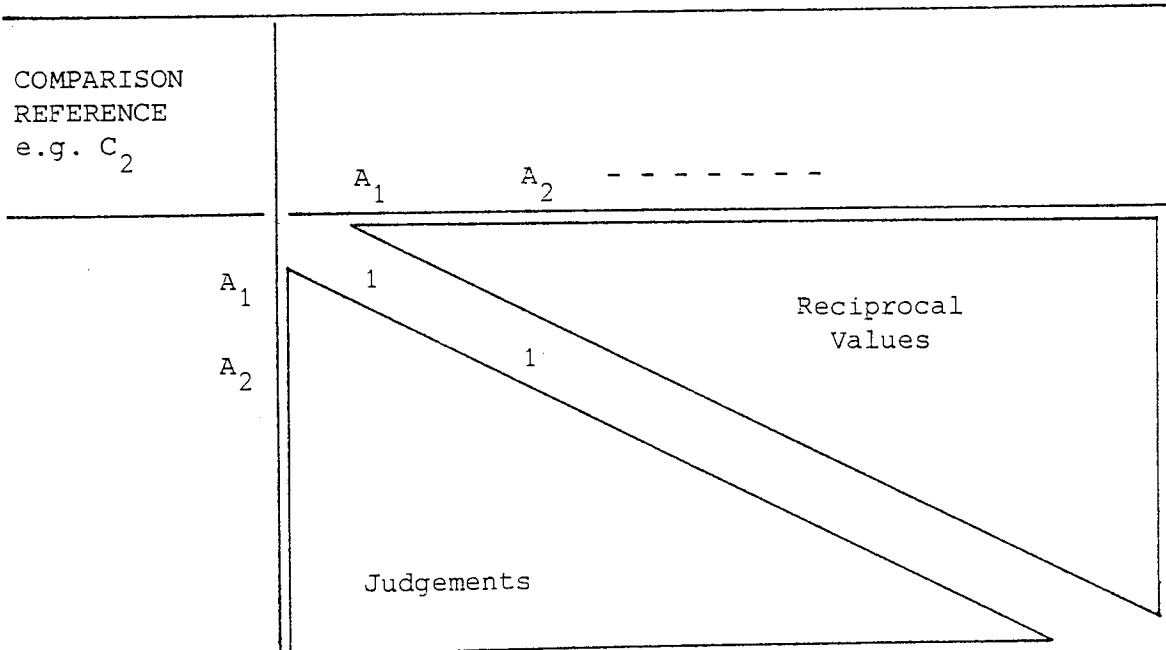
CRITERIA



ALTERNATIVES



a: Schematic of a General Alternatives Evaluation Hierarchy



b: Schematic of a Pairwise Comparison Matrix of Alternatives with Respect to Criterion C_2

Fig 4.2: Schematic Representations of a Hierarchy and a Comparison Matrix

Illustration has been removed for copyright restrictions

Source: Saaty, T.L. (1977): "A Scaling Method for Priorities in Hierarchical Structures", Journal of Mathematical Psychology, Vol.15, No.3, pp.234-281.

Table 4.1: Comparison Scale for the AHP Process

(3) A measurement theory to calculate the priorities and consistency of judgemental data; i.e. to use the pairwise comparison matrices to obtain a ranking vector of the elements of the lowest level of the hierarchy as related to the highest level.

Supposing that alternatives $A_1, A_2 \dots A_n$, have corresponding priority weights $W_1, W_2 \dots W_n$ respectively, and that, for the sake of argument, these weights are known, then the pairwise comparison matrix is:

$$\underline{A} = \begin{array}{c|cccc} & A_1 & A_2 & A_j \dots & A_n \\ \hline A_1 & W_1/W_1 & W_1/W_2 \dots \dots \dots & & W_1/W_n \\ A_2 & W_2/W_1 & W_2/W_2 \dots \dots \dots & & W_2/W_n \\ \vdots & \vdots & & & \\ A_i & \vdots & & & \\ \vdots & \vdots & & & \\ \vdots & \vdots & & & \\ A_n & W_n/W_1 & W_n/W_2 \dots \dots \dots & & W_n/W_n \end{array}$$

Where all the entries in this matrix are positive, and the matrix satisfies the reciprocal property $a_{ji} = 1/a_{ij}$ (where a_{ij} represent the degree of magnitude by which A_i is preferred to A_j), $\therefore a_{ii} = 1$ for all $i = 1, 2 \dots n$

The scale of weights $W_1, W_2 \dots W_n$ can be recovered by multiplying \underline{A} matrix on the right by the vector \underline{W} , obtaining the vector $n \underline{W}$; thus the problem is of the form:

$$\underline{A} \underline{W} = n \underline{W}$$

or $(\underline{A} - n \underline{I}) \underline{W} = \underline{0}$

The matrix \underline{A} is said to be consistent if it satisfies the consistency property

$$a_{ij} = a_{ik} \cdot a_{kj} \quad \text{for all } i, j \text{ \& } k.$$

If \underline{A} is consistent, then the problem is trivial and the solutions for \underline{W} is any column vector of matrix \underline{A} . However, in real life the precise values of (W_i/W_j) are unknown and must be estimated and since human judgements are frequently inconsistent and subject to intransitivity, then, the above equations cannot in general be satisfied completely; the AHP purpose is to allow the user to obtain a set of relative weights in the presence of this inconsistency.

It is known that in any matrix, small perturbations in the coefficients imply small perturbations in the eigenvalues, therefore if \underline{A}' is defined as the decision makers estimate of \underline{A} and \underline{W}' corresponds to \underline{A}' then:

$$\underline{A}' \underline{W}' = \lambda_{\max} \underline{W}'$$

$$(\underline{A}' - \lambda_{\max} \underline{I}) \underline{W}' = \underline{0}$$

where;

λ_{\max} = the largest eigen value of \underline{A}' matrix.

Hence, \underline{W}' can be obtained by solving this system of linear equations. This vector \underline{W}' , is the normalised eigenvector, with its elements being estimates of the relative weights (W_i) of each alternative (A_i) .

The difference between (λ_{\max}) and (n) becomes more pronounced as the degree of inconsistency of matrix \underline{A}' increases. In fact Saaty (1980) introduced the statistic:

$$\frac{\lambda_{\max} - n}{n - 1}$$

as a "consistency index", which gives the departure from consistency in estimating the ratios W_i/W_j , with consistency obtaining if and only if:

$$\lambda_{\max} = n$$

whence the value of the index is 0.

The overall composite vector, which measures the relative ranking of all elements at the lowest level of the hierarchy that enables the accomplishment of the highest goal (focus), is obtained by the method of hierarchical composition;

whereby the eigenvectors of a level in the hierarchy are weighted by the weights of the elements in the next level, and the sum is taken overall weighted eigenvectors entries corresponding to each element to obtain the composite vector of the element in a level. These are then used to weigh the eigenvectors corresponding in the next lower level, and so on, resulting in the composite vector of the lowest level of the hierarchy. These overall ranking weights (within the overall vectors) can provide the basis for decisions concerning elements in the lowest level of the hierarchy (Saaty, 1980).

The AHP technique has been applied to a variety of problems; Hannan (1983) applied it to rank tennis contestants; Wind & Saaty (1980) to a variety of marketing problems; Lusk (1979) to capital investments decisions; Arbel & Tong (1982) to options generation methodology and Saaty (1977b) to national transport planning. Conceptually, the AHP is applicable to the modelling of any choice situation which lends itself to a hierarchical representation.

The Ideal-Proximity Models base the ranking of the alternatives according to their similarity to an "ideal" solution. Where an "ideal" solution is defined as the imaginary alternative where the values (utilities) of the alternative impacts on the criteria are maximised simultaneously (Hwang & Yoon, 1981).

Formally, (A^*) is an ideal alternative if:

$$A^* = \max_i (x_{ij}) \quad \text{for all } j = 1 \text{ --- } n$$

i.e. $A^* = \{x_1^*, x_2^*, \text{---} \text{---} x_j^* \text{---} \text{---}\}$
 where $x_j^* =$ the "ideal" value for the j^{th} criterion overall the given alternatives.

i.e. the "ideal" solution is composed of all best criteria values attainable. The similarity to an ideal solution is based upon the concept that the chosen alternative should have the shortest overall distance from the ideal solution. This

distance could be measured by one of the multi-dimensional scaling methods e.g. by calculating the minimum weighted euclidean distance in a geometrical sense (Zeleny, 1974)

i.e. Formally:

$$d_i = \text{distance of alternative } (A_i) \\ \text{from the ideal } (A^*) \\ = \sqrt{\sum_{j=1}^n (V_{ij} - V_j^*)^2}$$

where:

$$V_{ij} = \text{weighted value (utility) of } x_{ij} \\ V_j^* = \text{weighted value (utility) of } x_j^* .$$

The alternative chosen is the one that has the minimum (d_i) i.e. the closest to the "ideal" solution.

Hwang & Yoon (1981) developed a computer package (called TOPSIS) which ranked alternatives according to an index reflecting the ratios of the distances, of the alternatives, from both the "best" and the "worst" solution.

The multi-dimensional scaling procedures raise many difficulties, such as; the assumptions that criteria are independant to justify the use of the Euclidean (or other) measures; the ability to express "ideal" points in space may be very limited; and, the requirement that the values of the alternative impacts on the criteria should be converted to weighted values (or utilities) to justify the logic of the measure, a basic difficulty in any decision situation. However, their advantage lies in the ability to deal with a large number of criteria and when the majority of them are expressed in a qualitative way (Hwang & Yoon, 1981).

4.3.5 The Behavioural Stream: This stream covers methods that are assumed to reflect the decision makers' behaviour in a multiple criteria decision

making environment (the assumption is usually based on some empirical validity (French, 1983).

The principal methods covered by this stream are:

- Lexicographic method
- Elimination-by-aspects method
- Procedural methods.

The Lexicographic method is based on the premise that, when faced with a multiple criteria decision situation, decision makers process the decision data sequentially; alternatives are first ranked in accordance with the most important criterion, and if one alternative has a higher criterion value than any of the alternatives, then, the alternative is chosen and the decision process ends. However, if some alternatives are tied on the most important criterion, the subset of tied alternatives are then compared on the next most important criterion. The process continues sequentially until a single alternative is chosen or until all criteria have been considered (Hwang & Yoon, 1981; Moskowitz & Wright, 1979) - hence, goal programming may be regarded as a mathematical lexicographic method (Moskowitz & Wright, 1979).

Tversky (1969) suggested that a lexicographic semi-order might better explain the decision makers actual behaviour in a decision making environment than the above heuristic. He stated that, in most cases, it makes sense to allow bands of imperfect discrimination so that one alternative is not judged better just because it has a slightly better value on one criterion. In a lexicographic semi-order, a second criterion is considered not only in cases where values for several alternatives on the most important criterion are equal but also for cases where the differences between the values on the most important criterion are not significant or noticeable. This same process may then be used for further criteria if more than one alternative still remain.

The lexicographic method has received serious consideration as a decision technique because of its limited information requirements, since it needs only ordering or ranking information and not (necessarily) numerical values (Hwang & Yoon, 1981). However, it may not be an advantage in utilizing only a small part of the available information. In addition, the method has been criticised by French (1983) on the basis that; it does not explain decision makers preferences in every circumstances, just that in some circumstances it has empirical validity; and, the semi-order modification of Tversky suffer, like any other behavioural model, from possible intransitivities.

Elimination-by-aspects is a classical human decision procedure which has been used for a long time. Tversky (1972a; 1972b) formalized the decision process mathematically with the introduction of choice probability as a theoretical concept in the analysis of choice. He described choice as a covert sequential elimination process, where alternatives are viewed as sets of aspects, and that at each stage in the choice process an aspect is selected with probability proportional to its importance; alternatives that are viewed as unsatisfactory on the selected aspect are eliminated (aspects could represent values along some fixed quantitative or qualitative dimensions (criteria), or they could be arbitrary features of the alternatives that do not fit into any single dimensional structure).

The Elimination-by-aspects(EBA) method has some advantages; it is relatively easy to apply; it involves no numerical computation; and it is easy to explain and justify in terms of a priority ordering defined on the aspects. However, the flaw of its logic has been summarised by Hwang & Yoon (1981) thus:

 Aston University

Content has been removed for copyright reasons

However, they conceded that:

"There may be many contexts in which it provides a good approximation to much more complicated compensatory models and thus serve as a useful simplification procedure."

Procedural methods in the behavioural stream, cover the various methods and procedures that have been suggested by their respective authors as leading to sound and effective decision making. These methods are usually descriptive (Slovic et al, 1977) and their basic justification is that they all have been found to explain some decision makers choices in some circumstances (French, 1983). These methods include; "process description" where decision makers are asked to think aloud as they choose among various alternatives (Bettman, 1974; Slovic et al, 1977); "script processing" where the decision makers depend on their previous learning and experience (Slovic et al, 1977; Abelson, 1976), and "policy capture" where regression analysis is adopted to weigh the relevant factors considered in reaching a decision (Porter et al, 1980).

Many other authors have proposed procedures for effective decision making. Janis & Mann (1977) have reviewed this extensive literature and have extracted a procedure which, they claimed, if followed will lead to effective and informed decision making. Their procedure is made up of seven steps which the decision maker should follow to the best of his ability and within his information processing capabilities. They actually proposed to employ these steps as the criterion against which effective decision making should be ascertained, but they did not offer any systematic data to support their claim. In their words, an effective decision making aid should enable the decision maker to:

- "1. thoroughly canvass a wide range of alternative courses of action;
2. survey the full range of objectives to be fulfilled and the values implicated by the choice;
3. carefully weigh whatever he knows about the costs and risks of negative consequences, as well as the positive consequences, that could flow from each alternative;

4. intensively search for new information relevant to further evaluation of the alternatives;
5. correctly assimilate and takes account of any new information or expert judgement to which he is exposed, even when the information or judgement does not support the course of action he initially prefers;
6. reexamine the positive and negative consequences of all known alternatives, including those originally regarded as unacceptable, before making a final choice;
7. make detailed provisions for implementing or executing the chosen course of action, with special attention to contingency plans that might be required if various known risks were to materialize."

Their working assumption is that failure to meet any of these seven criteria when a person is making a fundamental decision (one with major consequences for attaining or failing to attain important values) constitutes a defect in the decision-making process. The more defects, the more likely the decision maker will undergo unanticipated setbacks and experience postdecisional regret.

However, it may be concluded that all procedural methods are highly context specific and their worth, in improving the quality of decision making in general situations, has not been adequately proven.

4.4 BASIC ISSUES IN MCDM

The general MCDM situation, outlined in section 4.2, was adopted as the basis for the review of the MCDM methods, procedures and models outlined in section 4.3. However, there remain some basic and related issues which directly affect the worthiness of any decision making method. These issues concern the basic elements of the general decision situation namely:

- Decision makers (DMS), their number and behaviour.
- Alternatives (A_i), their generation and richness.
- Criteria (X_j), their selection and importance.

These issues will be discussed in turn.

4.4.1 Decision Makers - Behaviour and Multiplicity: The behaviour of human beings in situations involving making decisions have been the subject of a multitude of studies (see Slovic et al, 1977; Einhorn & Hogarth, 1981, for reviews). These studies have concluded that; he (the human being) is a reluctant decision maker (Janis & Mann, 1977); his mind can only encompass a limited number of distinct variables at any one time, and that if he is asked to process too many factors simultaneously, he will resort to very poor heuristics (Miller, 1956); at the moment of decisions, empirical results suggest, he seldom considers more than two or three factors (French, 1983); intransitivity of preference, experiments suggest, can occur with situations involving fewer than seven criteria (Tversky, 1969; Shepard, 1964); he displays 'cognitive' bias towards choices that are familiar and comprehensible (Slovic et al, 1977; Einhorn & Hogarth, 1981); he displays an 'anchoring' bias towards choices that he initially formulates after preliminary calculations and considerations (Tversky & Kahnemann, 1974).

The behavioural studies indicate also that, en route to a decision, the DM use many rules and strategies, these include conjunctive, disjunctive, lexicographic rules and the principle of dominance (Svenson, 1979). A typical choice may involve several stages, utilizing different rules at different junctures. Early in the process, DMS tend to compare a number of alternatives on the same criterion and use conjunctive rules to reject some alternatives from further consideration, and that, only later, they appear to employ compensatory weighing of advantages and disadvantages on the reduced set of alternatives (Slovic, et al, 1977). Features that complicate the decision situation, such as incomplete data, incommensurable data dimensions, information overload, time pressures, and multiplicity of alternatives seem to encourage strain-reducing non-compensatory strategies (Slovic & Macphillamy, 1974; Wright, 1974). The adoption of these strategies is reflected by the general tendency, according to the behavioural theorists, of the decision makers to; "satisfice" rather than

"otpimise" i.e. selecting alternatives that are "good-enough" instead of the "best"; and prefer simple and easy decision making methods and strategies, a proposition elaborated by Slovic et al (1977) thus:

"In general, people appear to prefer strategies that are easy to justify and do not involve reliance on relative weights, trade-off functions, or other numerical computations."

Due to the above behavioural patterns and tendencies, most, if not all, decision making methods and procedures have been claimed to be geared to overcome these biases and shortcomings, and generally help the decision maker to make enlightened and informed decisions, without ever claiming to make the decisions on his behalf. French (1983), stated that the primary function of decision aids, is:

"To help the decision maker understand his situation, his preferences and his beliefs better so that through this understanding he may make a more informed decision."

The help of the methods and procedures is achieved by the formal analysis of the decision situation they employ, and by not depending on the holistic appraisal of the alternatives by the decision makers. Cleland & King (1983) justified the use of formal decision analysis, thus:

"Human beings are not known for their ability to comprehend complex problems involving many interacting factors ---- (therefore) any formal analysis or attempt at formal analysis is valuable since it serves at least to make decision makers think about the right things."

Keeney (1981) thus:

"It is not a panacea for solving complex choice problems. It provides help for the decision makers but, of course, it doesn't replace key individuals. Properly used, decision analysis can assist in understanding, evaluating and communicating the complexities involved in the decision."

Another major issue to be considered is the multiplicity of decision makers. Throughout this review, it has been assumed that there is a single decision maker (or a group with one voice - a single entity) who articulates

preferences. However, in real life decision making involves a multiplicity of individuals, each is driven by a mix of self-interests, perceptions of the decision situations and the information at hand (Blau, 1964), and each constrained by his location in the social structure (Pettigrew, 1973); Blau (1964) suggested that the basic heuristic for individual decision making, within a social structure is:

"Men seek to adjust social conditions to achieve their ends."

There is a vast amount of literature by organisational theorists about the motivation behind individual decision making and the origins of conflicts, and the strategies followed for their resolution, within an organisational structure (Pettigrew, 1973). Most prominent among these theories are the ones advanced by March & Simon (1958) and Cyert & March (1963). March & Simon advocated that people seek to satisfice and not maximize in making decisions and that there are various cognitive limits on rational behaviour. They defined conflict as:

"A breakdown in the standard mechanisms of decision making so that an individual or group experiences difficulty in selecting an action alternative."

They went on to stress that, where conflict is perceived, motivation to reduce conflict is generated. They also advanced the reasons for conflict between groups having an interdependent relationship (an organisation) as; the need for joint decision making; differences in goals and sub-goals between the groups; and, differences in their knowledge and perceptions.

Cyert & March (1963) differed from March & Simon in one major respect; the stress they gave to the organisation as a coalition, and to decision making as a political process. They regarded conflict of interests, based on sub-goal differentiation, as "normal" part of organisational life, and they accepted that conflict resolution can only be partially successful, and stated that:

"Most organisations most of the time exist and thrive with considerable latent conflict of goals."

Although they pointed out the importance of coalition formation and the desire of

any sub-group to generate support for its particular interests, nevertheless, they gave scant attention to the processes involved, and they used general statements such as:

"Support came about through a rather complex mixture of personal, organisational, and general organisational goals(and) Any alternative that satisfies the constraints and secures suitably powerful support within the organisation is likely to be adopted";

to explain the process of actual choice and selection.

Organisational behavioural theorists in general, have not attempted to rationalise a prescriptive procedure or method that can be used to derive an overall group decision based on the integration of individual judgements of the members of the group (Pettigrew, 1973). Their main suggestions have been to promote techniques and methods that enhance information exchange between the decision makers and aimed to arrive at a consensus among them (these methods include Delphi, brainstorming, etc (Porter et al, 1980)). Their general approaches tend to converge on the proposition that (Pettigrew, 1973):

"The final decision outcome will evolve out of the process of power mobilization attempted by each party in support of its demand."

However, some decision analysts (Keeney & Raiffa, 1976; Keeney & Kirkwood, 1975; Dyer & Sarin, 1979; Eliasberg & Winkler, 1981) have noted the similarity between the aggregation of the decision makers' preferences into a group utility function and the assessment of a multi-attribute utility function for one individual, and have attempted to produce group functions based on this similarity. But, French (1982) raises two basic objections to these approaches; first, the impossibility of operationalising the concepts necessary to conduct an interpersonal comparison of preferences; and, second, their contradiction to Arrow's impossibility theorem (Arrow, 1963) which implied that there is no procedure that can combine several individual's preferences and simultaneously satisfy very reasonable assumptions about the process of social choice. French went on to suggest that:

"It is fallacious to believe that a group can act as a single entity and decide upon a course of action. A group doesn't possess a mind of its own and so cannot choose; in which case there is no rationale for forming a group utility function."

On the other hand, Hwang & Yoon (1981) suggested that conjunctive methods may be directly applied in multi-decision-makers situations, if each decision maker imposes different constraint. Others suggested aggregating the decision makers preferences by taking their arithmetic means (Churchman & Ackoff, 1954), or, their weighted average depending upon the individual's power in a group (Shapely & Shubic, 1954), or, by using the Delphi procedures to help the group reaching consensus (Tell, 1977). However, Hwang & Yoon (1981) indicated that not much has been done in the way of developing methodologies to deal with multi-decision-makers situations and problems.

The difficulties of dealing with multi-decision-makers situations, have caused many researchers to gloss over this issue when applying the various MCDM methods in group situations. For example; Wind & Saaty (1980) in their marketing applications, stated that:

"Individual judgements are made in a group setting, involving the relevant decision makers, and serve as a basis for a discussion on the reason for specific judgements. Such situations often result in agreement."

Lusk (1979) in the application of AHP to hospital investment, stated that the judgement matrix was formulated by the financial vice president; Saaty (1977), in his Sudan transport study, stated that

"Participants were the foreign minister, the minister of transport and officials from the planning commission";

but, he does not mention the process by which agreements were reached on the final entries of the judgemental matrices.

Finally, in respect of approaches to multi-decision makers situations, we tend to agree with French (1982) conclusion that, in a group setting:

"There is no single decision present; there are many, one for each member of the group - - - -(Hence), it is not necessary to extend

single person theory to groups; it is only necessary to consider its use in the context of a group",

and he saw the role of decision analysts as:

"To advise the individual members of the group and to help communication and understanding between the members."

4.4.2 Alternatives - Generation and Richness: The richness of the set of alternatives, presented to the decision makers, has been recognised, by many authors, as a basic requirement for enlightened decision making. For example; Arbel & Tong (1980) stated that:

"The decision makers cannot make an informed choice unless they consider a rich set of decision options";

and, Cleland & King (1983) stressed that:

"To pursue objectives meaningfully the decision maker must have available alternative actions which can promote the state of affairs desired. These available alternatives, together with a state of doubt as to which is best, constitute the heart of any decision problem."

These authors have also stressed that the process of alternative generation should not be left entirely unstructured i.e. to the judgement and intuition of decision makers. Cleland & King (1983) suggested that decision makers, who base their thinking solely on subjective experience, judgements and intuition, usually fail to recognise the existence of alternatives. March & Simon (1958) indicated that, even when they generate alternatives, decision makers depend on their specification of the decision situation; this specification is influenced by selective perception and sub-goal identification. Cleland & King (1983) summed up the inability of the decision makers, when left unaided, to generate rich alternatives, thus:

"The judgements of all of us is conditioned by our range of past experience, and most of us do not conduct our daily lines in a fashion which is conducive to the generation of new alternatives."

Many reasons have been advanced to explain the inability of decision makers to generate rich set of alternatives in unstructured situations, these

include; the propensity of the human mind to focus too quickly on two or three alternatives (French, 1983); the effect of cognitive biases (Slovic et al, 1977); the effect of "anchoring" (Tversky & Kahneman, 1974); and, the individual's decision style (MacCrimmon & Taylor, 1975).

However, the most important effect on the alternative generation process, in an organisational setting, has been identified as the effect of analysts, designers and experts. These affect the range of alternatives, considered by the decision makers, by the application of their own value judgements and biases (Little & Mirrlees, 1976). Sodberg (1963) attributed the reasons for this to the desire for power and concern for personal advancement; and, Walter (1966) to the desire to increase their influence on their superiors. As manifestation of the experts' influence, Crozier (1964) cited the example of the technical engineer who was able to control the actions of the director by setting technical limits on what was and what was not possible to do.

Due to the effects of the above reasons, and to ensure that the decision makers consider a rich set of alternatives, the alternative generation phase of any decision making process, most authors agreed, had to be structured according to bases that will ensure the richness of the set of alternatives presented. Some authors have actually proposed methodologies and techniques to achieve this. For example; Cleland & King (1983) emphasised the need for a group process that will facilitate creativity and advocated the use of system analysis ideas and techniques to aid in the definition and the development of opportunities and alternatives; Arbel & Tong (1980) noted the scant attention given to the issue of alternative generation in the decision science literature and suggested the use of a templating methodology, based on Saaty's AHP, to identify the salient factors in the decision situation and hence enhancing the alternative generation process; and Zwicky (1969) used morphological analysis to formulate alternative jet engine configurations.

Recent work on the use of cognitive mapping (Eden et al, 1983); the use of systems dynamics concepts for system description (Wolstenholme & Coyle, 1983); and, the use of games in problem structuring (Bennett & Huxham, 1982), could all be regarded as falling within the stream of problem specification and hence, alternative generation. But, on the whole, relatively little has been done on the structuring of the alternatives generation process. This may be explained by the proposition that most decision scientists view this process as an act of creative insight and informed judgements, and hence cannot be guided by normative techniques (Arbel & Tong, 1983). Hence, most analysts (e.g. Porter et al, 1980) advocate only the use of techniques that enhances creativity such as; brainstorming, Delphi, and expert advice. Porter et al (1980) have identified the factors that have the major influence on the creative process of alternative generation as:

- Centrality & significance of the alternatives involved.
- Resource limitations constraining the decision situation.
- Cognitive limitations of decision makers, analysts and other participants.
- Political factors (value considerations)

4.4.3 Criteria - Selection and Importance: The selection of the criteria according to which choice among alternatives is made, and the importance attached to each criterion in the decision making process, are both matters of judgement and differ among individual decision makers (Pettigrew, 1973). Therefore, they are subject to the same influencing factors outlined in the above two sections (4.4.1 and 4.4.2).

Slovic et al (1977) noted that techniques for the selection of criteria are rarely discussed in the literature. But those who faced this problem have concentrated on creativity enhancing techniques e.g. Gardiner & Edwards (1975)

used the Delphi technique; Humphreys & Humphreys (1975) and Eden et al (1983) suggested using the repertory grid technique; Beach et al (1976) suggested using extensive interviewing techniques, involving several interactions with different decision makers, to arrive at a list of relevant criteria; and, Kepner & Tregoe (1981) suggested the classification of criteria into "must" and "want" types as a way to assist their selection and consideration by the decision makers.

4.5 PRINCIPLES FOR EFFECTIVE MCDM

From the above review of methods, models and issues, it can be deduced that an effective decision making methodology, that could be applied within the context of technological development projects detailed in Chapter 3, should be based on the following principles:

- (a) Decision makers should consider a rich set of options; this richness should be facilitated by a structured and systematic approach.
- (b) The alternatives should be evaluated with respect to criteria that encompass the salient factors in the situation and reflect the domain of concern and the objectives of the actors involved.
- (c) Alternatives and criteria should be compared pairwise (pairwise comparison being the easiest form of comparison (Slovic et al, 1977)). The methodology should structure the decision situations in such a way so as to compare alternatives with respect to each criterion, and then, the criteria with respect to an overall goal.
- (d) The ranking of alternatives and criteria should be obtained easily in spite of expected inconsistencies by the decision makers.
- (e) The scale used to express preferences among options, should be detailed enough to facilitate differentiation, but, should also correspond to the human range of discrimination.

- (f) The methodology should not attempt to derive a function to represent the multiple decision makers, but should aim towards the enhancement of dialogue and interaction between them, and in making their attitudes, values and concerns apparent to each other.
- (g) Finally, the methodology should not aim to arrive at a decision on behalf of the DMS, but, should aim to assist them to arrive at an enlightened decision with a higher level of awareness.

Chapter 5 will be devoted to the formulation of a methodology, based on the above principles, and suitable for the context of technological development projects.

CHAPTER 5

AN INTEGRATIVE METHODOLOGY

5.1 INTRODUCTION

The principles outlined at the end of chapter 4 (section 4.5), form the bases according to which the proposed decision making methodology will be formulated. The operating environment for the methodology is taken to be the decision making system of technological development projects as outlined in chapter 3 and as embedded within the decision making context specified at the end of chapter 2. The main aim of the methodology is to integrate the consideration of the relevant evaluation criteria, the prevalent environmental and policy factors and the concerns and objectives of the actors into a unifying decision making process which strives to facilitate enlightened decision making and to enhance learning and interaction.

This chapter is devoted to the outline of this methodology. Section 5.2 is devoted to the setting down of the basic notations which will be adopted in the methodology. Section 5.3 is devoted to the detailed outline of the methodology; its basic structure and its constituent phases. Section 5.4 is devoted to the discussion of issues and factors related to the implementation of the methodology in real-life decision making situations.

5.2 NOTATION AND STRUCTURING

Adopting the definition of a "project" as (see section 3.2):

"A set of tasks geared to achieve a given goal"

will mean that the project is defined by stating the goal it sets out to achieve. In that sense, projects involve no alternatives, and the decisions related to projects will only concern whether they are approved for implementation or not.

The concern here is not with whether a project is carried out or not, but with the mechanism of the decision making process during the project's planning and implementation cycle after it has been approved for implementation.

To ensure systemic analysis of decision situations which arise during the

planning and implementation cycle of projects, a hierarchy will be adopted whereby projects are divided into "Decision areas" - with each of these areas corresponding to an identifiable part of the project and encompassing relevant variables that can take multiple values/states - and "Options" - with each of those options made up of the combination of the states of the variables within, and across, the decision areas; Fig 5.1 shows an outline of this hierarchy. This problem structuring approach has features in common with the AIDA (Analysis of Inter-related Decision Areas) approach of Friend and Jessop (1976), the morphological analysis approach described in Porter et al (1980) and Zwicky (1969) and the LRC (Linear Responsibility Charts) approach of Cleland & King (1983), and it has the advantage of each option containing states of all the relevant variables, hence making it possible that interdependencies, connectivities and higher order impacts are considered when the options are evaluated, a requirement which is fundamental to the systems approach (Cleland & King, 1983).

5.3 DECISION MAKING METHODOLOGY

Various versions of the basic structure of the decision making process have been outlined by many authors e.g. Porter et al (1980); Cleland & King (1983); Friend & Jessop (1976); Arbel & Tong (1982). However, the following breakdown of the process captures the salient features of these versions and will serve as a basis for the detailed classification of the process:

- The options generation phase
- The options evaluation phase
- The options selection phase.

Obviously the above phases should be followed by the "action" phase; this phase will not be treated here as a constituent phase of the decision process, but, rather, as a result of it.

The three phases proposed for the decision making process are to be

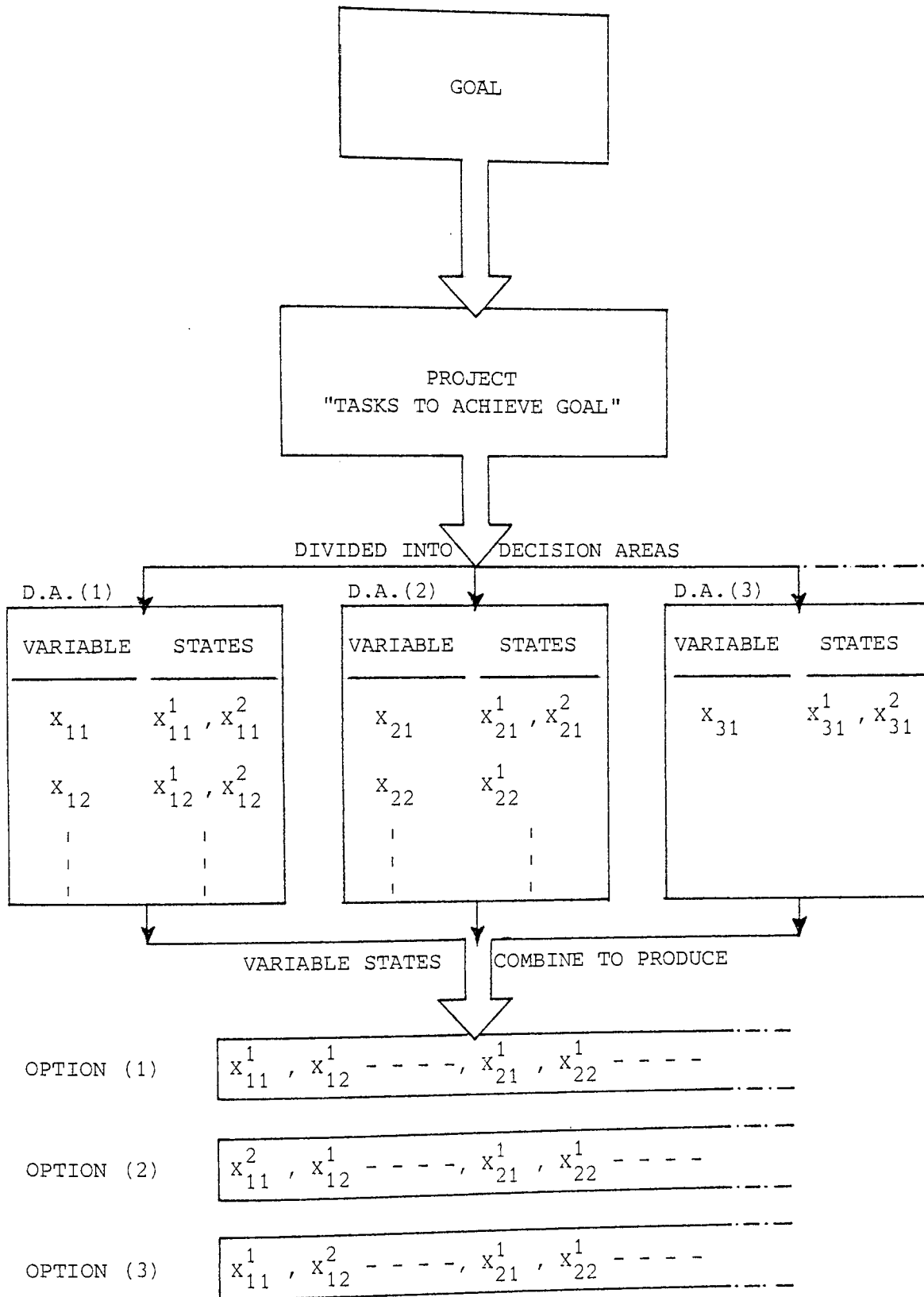


Fig 5.1: The Notation Hierarchy for Options Generation

triggered at any stage of the project's planning and implementation cycle; they could be triggered as a reaction to a perceived problem situation, or, as a proaction to achieve a given goal or utilize a certain opportunity. However, it is envisaged that in the context of large technical projects, the proposed decision process will mostly be triggered during the "conceptual design" and "detailed design" stages of the project's planning and implementation cycle, since, it is at these stages that most of the technological decisions have to be made.

The phases of the decision making process will be treated in turn.

5.3.1 The Options Generation Phase: To satisfy the principle that the quality of any decision is dependent on the richness of the options considered (Arbel & Tong, 1982; Cleland & King, 1983), the option generation phase has to be structured according to a methodology that will ensure this richness.

To facilitate this structuring, the options generation phase will be divided into the following steps:

- A. Amplification
- B. Attenuation.

A. Amplification: It is the process whereby the known set of options is enhanced and enriched by adopting the tools of creative interactions, brainstorming and other creativity stimulants. Also, methods such as expert advice, data gathering, information exchange and research are usually incorporated to further enrich this process.

The amplification step should be conducted with a conscious and systematic effort, by all the participants, to exclude most, if not all, constraints from their considerations and deliberations. This is important, since, the exclusion of any option due to a perceived constraint represent in itself a value judgement by the actor and should be avoided at this initial stage of the decision process. The

assumption of the total absence of constraints is similar to the concept of idealised planning advocated by Ackoff (1977).

The amplification step should ensure that the decision process does not focus too quickly on the familiar and most obvious options, and that analysts, experts and technocrats do not filter options according to their implicitly held values and their personal interpretation of policies, standards and guidelines. Actors' participation in this step, or, at least their awareness of its output, is necessary to ensure that no prior filtration, based on implicit assumptions, is done, and that the options generated reflect their combined knowledge, concerns and objectives.

The amplification step is simplified by the adoption of the notation hierarchy of Fig 5.1, since the process of options enrichment will result automatically from the process of dividing the project into relevant decision areas, properly identifying their relevant variables and the accurate estimation of the possible states that each of the variables may assume within the specific context of the decision situation.

B. Attenuation: It is the process whereby the rich set of options is reduced via the application of the relevant criteria. In general, preliminary analysis will reveal that some states of the variables - within the decision areas and/or their combinations across the decision areas - when related to established and agreed policies, standards and resource constraints will not be acceptable or feasible, and hence options containing these states and combinations have to be eliminated.

The methods of the filtering stream of MCDM (see section 4.3.1), especially the disjunctive, conjunctive and dominance procedures, are most appropriate for the attenuation step, and it is envisaged that cut-off values, policies and standards against which the filtration is carried, should be chosen in

such a way as to raise no disagreements by the actors; values, policies and standards that raise disagreements should be ignored at this stage and left to be tackled at the more elaborate phase of options evaluation.

The detailed application of the attenuation process is context-specific, however, in most cases involving large technological project, the attenuation process is a synthesis of three classes of filtration:

- a. Policy filtering
- b. Environmental filtering
- c. System filtering.

(The above classification is based on Friend & Jessop's (1976) identification of the uncertainties that affect any decision situation.)

a. Policy filtering: when the reasons for options elimination are the established policies related to the context of the decision situation e.g. supplier diversification policy; foreign exchange policy; energy policy; etc.

The levels of policies affecting the decision situation could be organisational, sectoral or national, with the difficulty of adjustment of these policies increasing as the levels rise. In decision making, the established policies are usually adhered to and the process of policy adjustment - via dialogue, interaction and feedback - is usually slow and cumulative, especially within decision making contexts adopting the "rational comprehensive" approach to planning and decision making. Usually these adjustments have to be carried out by interaction with the respective Arbiters of the relevant level of responsibility.

Conscious and structured policy filtering has the advantages of; raising the awareness of the various organisational units, and levels, of established policies; strengthening the organisational "glue"; enhancing the transmission of the organisational ethos to the various levels; and, specifically, raising the awareness of the Arbiters of the impact of the policies, of which they are guardians, hence enhancing the process of adaptation and learning.

b. Environmental filtering : when the reasons for options elimination are factors in the environment within which the organisation is operating e.g. economic factors; social factors; legal issues.

The general environment and the organisation's operating environment impose constraints and limits on the decision situation under consideration. The filtering is done by relating the results of the preliminary analysis of the impacts of the states of the constituent variables, and their combinations, to values of the environmental factors which are considered by the actors as the limits (or thresholds or cut-offs) beyond which the options should be eliminated e.g. some forms of technologies are too expensive.

The environmental factors, by definition, are outside the sphere of control of the organisation (Churchman, 1979). Hence, any adjustment of this filter - by the reevaluation of the factors' limits - can only be done by interaction and negotiations with higher authorities which have the control of these factors within their jurisdiction e.g. negotiation with the financing agencies to increase the budget ceiling. Obviously the adjustment of this filter may, sometimes, only be done by policy dialogue and adjustment of the policy filter.

c. System filtering: when the reasons for elimination are factors in the internal environment of the organisation itself. Specifically, the eliminations are due to the fact that the decision areas (and the project) are part of a larger system e.g. standardization; complementarity; technical feasibility.

Some of the variables states (and their combinations) may have to be eliminated because they will not be fit (or suitable) to include within the existing system. Hence, if the existing equipment is of a certain technological type, then, it may be considered as unacceptable burden to diversify into another type of technology.

Revisions and system modifications are the means to adjust this filter; this

could in turn lead to the reevaluation of the environmental factors and/or policy adjustment via dialogue.

Fig 5.2 illustrates the mechanics of the filtering process and Fig 5.3 illustrates the outlines of the steps involved in the options generation phase.

The output of the options generation phase is a set of feasible options which are then dealt with extensively in the options evaluation phase.

5.3.2 The Options Evaluation Phase: The basic difference between this phase and the attenuation step of the options generation phase, is the level of analysis of the options impacts, which is much more detailed and extensive in this phase.

This phase commences with a feasible set of options (Fig 5.3), where all these options are assumed to be effective, in that they are all capable of achieving the basic purposes, aims and objectives of the project. But, they result in different impacts, require varying amounts of resources and display various characteristics. It is the analysis of these impacts, requirements and characteristics that forms the basis for the options evaluation.

This phase may be divided into the following three distinct but closely linked steps:

- a. Evaluation criteria selection
- b. Analysis of impacts of options
- c. Ranking of options by the actors.

These steps will be treated in turn.

a. Evaluation criteria selection: The selection of the evaluation criteria is a crucial step in any decision making situation, with decision makers tending to concentrate on criteria that directly relate to their objectives and aims which, in turn, directly relate to the span and scope of their responsibilities (see chapter

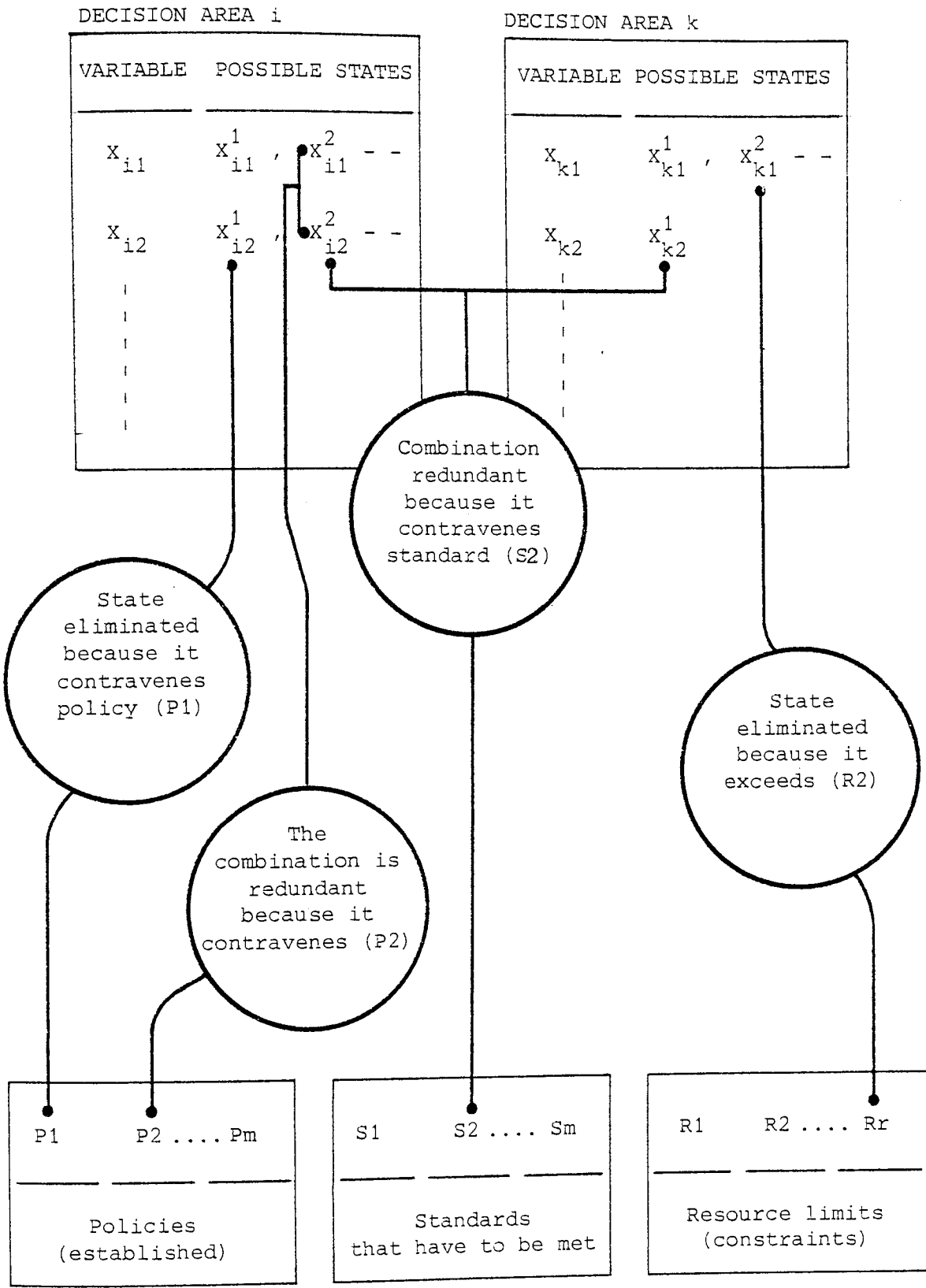


Fig 5.2: The Mechanism of the Attenuation Process

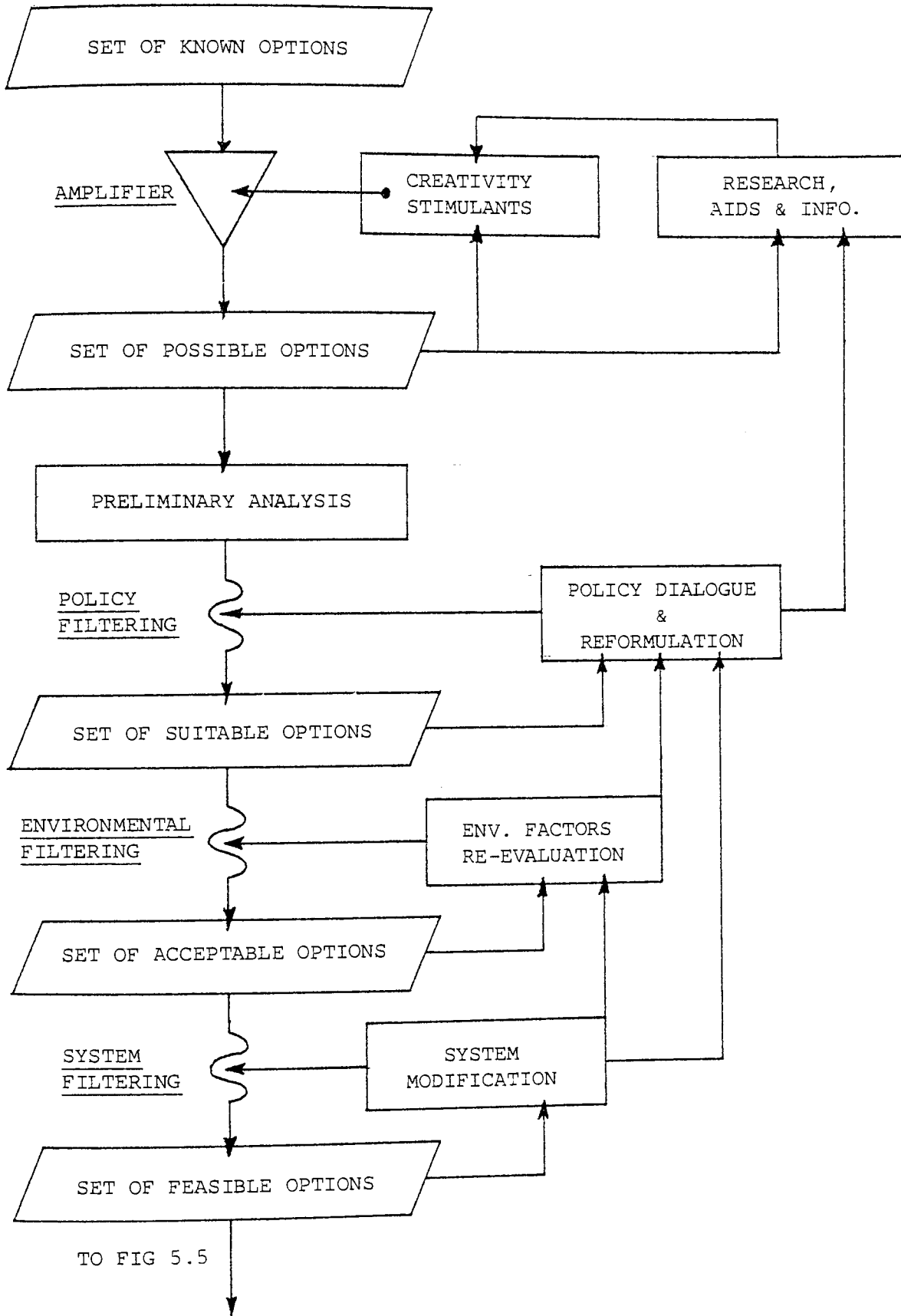


Fig 5.3: The Options Generation Process

3). Also, there is a general bias towards criteria that can be quantified and have a high degree of familiarity e.g. the economic criterion. Hence, to ensure that a comprehensive set of criteria is chosen, a conscious and systematic effort to achieve this should be adopted to overcome biases and anchoring. It is envisaged that, in most circumstances, one of the opinion methods - brainstorming; panel discussions; delphi; surveys; etc - could be used to compile a set of criteria which reflect the concerns and objectives of the actors involved. It is also envisaged that the Arbiters will participate actively in this process to ensure a fair hearing for all the relevant actors. But, this process is obviously constrained by resource limitations including time, cognitive limitations of the participants and the prevailing political environment of decision making.

b. Analysis of impacts of options: The analysis of the impacts of the options on the selected criteria - both primary and higher order impacts - is usually carried out by analysts and specialists with expert knowledge in their respective areas. The analysis is to be divided according to specializations and expertise, hence enhancing the experts morale and efficiency (Porter et al, 1980).

The impacts of the options are either quantifiable - when objective bases of measure could be defined e.g. net present value - or, non-quantifiable - where comparisons between the impacts could only be reflected by adopting an artificial scale e.g. high/low flexibility. In the former case, the analysts and the experts should carry out a detailed and thorough analysis of the impacts, while, in the latter case they could only give general comments on trends and scales of the anticipated impacts with the aim of helping the actors to form their comparison judgements.

The output of the analysis is to be circulated to all the principal actors involved (Arbiters, Operators, Planners & Implementors) with the proviso that it should be presented in clear and easy format. The analysis will serve as the basis for the next step in the evaluation phase - the ranking step.

c. Ranking of options by the actors: The output of this step is envisaged to be the overall ranking of the options by the actors involved. The options ranking vector, representing the collective attitude of the principal actors, may be obtained after a process of interaction and dialogue among the actors resulting in their agreement and consensus. However, in decision situations where options ranking cannot be agreed upon by the principal actors, or, in decision situations where the issues involved are important and their impacts are far reaching, a structured soliciting of the attitudes, concerns and judgements of the principal actors is deemed necessary. In such situations it is proposed that ranking vectors are produced for each of the relevant actors in a systematic and structured way.

There are many methods and models, within the realm of MCDM, that can be adopted to produce the actors' ranking vectors, however, Saaty's Analytical Hierarchy Process (AHP) (Saaty, 1980) is recommended as the most suitable method for the ranking process (the AHP is reviewed in section 4.3.4); this is because of its hierarchical structuring features and its satisfaction of most of the principles for effective decision making outlined in section 4.5. In the context of technological projects the basic decision making hierarchy, for the AHP, consists of three levels:

- 1st level; focus on the overall objective encompassing the decision situation; usually arrived at by consensus.
- 2nd level; the evaluation criteria according to which the options will be evaluated.
- 3rd level; the options that are feasible and effective in achieving the focus of the decision situation.

The ranking process of the AHP is divided into two stages; the first is the construction of the pairwise-comparison matrices of the options as related to each of the criteria in turn. These matrices may be divided into two categories; ratio and judgemental matrices. The ratio matrices are applicable when objective and

quantifiable measures of the options' impact on the selected criterion exist, with the entries, either, being the pairwise ratios of these impacts (Lusk, 1979) or, the quantifiable measures serving as the guidelines according to which the pairwise-comparison matrices are constructed. The judgemental matrices, anticipated to be the more common in the context of technological development projects, are suitable for the pairwise comparison of the options' impacts whether objective measure exist or not, with the 1-9 scale being the basic measure of the pairwise comparison. From these matrices, vectors ranking the options on each criterion may be obtained for each principal actor. The second stage is the construction of the pairwise-comparison matrices of the relevant criteria as related to the focus of the decision situation. These are judgemental type matrices adopting the 1-9 scale. From these matrices, vectors ranking the relevance of the criteria to the focus of the situation may be obtained for each actor. (Note that criteria on which the options' impacts cannot be differentiated - a common occurrence in practice (Belton, 1985) - should be noted and dropped from the ranking, hence reducing the size of the ranking process.)

The result of the application of the AHP is a normalised and composite vector of weights for the entire hierarchy, for each of the principal actors in the decision situation. These composite vectors measures the relative ranking of all the elements at the lowest levels (options) that enables the accomplishment of the highest level (focus) of the hierarchy.

The output vectors of the ranking process, representing the rankings of the principal actors, will form the basis of the next phase of the decision making process - the options selection phase.

5.3.3 The Options Selection Phase: It is proposed to use the AHP results of the options evaluation phase as the reflection of concerns, judgements and attitudes of the relevant actors, and to use this information as the basis for the

options selection phase.

In the context of technological projects, agreement between the Operators, Planners and Implementors may be achieved in most decision situations via the process of interaction and negotiation. However, the focus here is on situations where agreement cannot be reached and differences are irreconcilable or, where thorough evaluation is considered necessary. In those situations the Arbiters' intervention is deemed necessary for the options selection process. The adoption of the AHP process to reflect the actors judgements will enable the Arbiters to be acquainted with these judgements prior to them forcing a decision. These actors' overall judgements are displayed by the composite ranking vector generated for each of the relevant actors by the AHP process. Let the vectors be:

O for the Operators

I for the Implementors

P for the Planners

where the elements of each of the above vectors represent the overall ranking weights given to the options by the respective actor.

The Arbiters may take their decisions by depending on the information contained in the above vectors and their implicit holistic evaluations of the options, criteria and the relevance of the actors involved. However, in major and basic conflict situation, it may be advantageous if a composite ranking vector for the Arbiters themselves is generated (let it be denoted by A). This vector could then be used as a reference to reflect the range and extent of the differences between the actors. These differences may be obtained by the simple means of vector subtraction

i.e. A - P

A - O

A - I

Hence, a matrix may be constructed, with the vectors resulting from the above

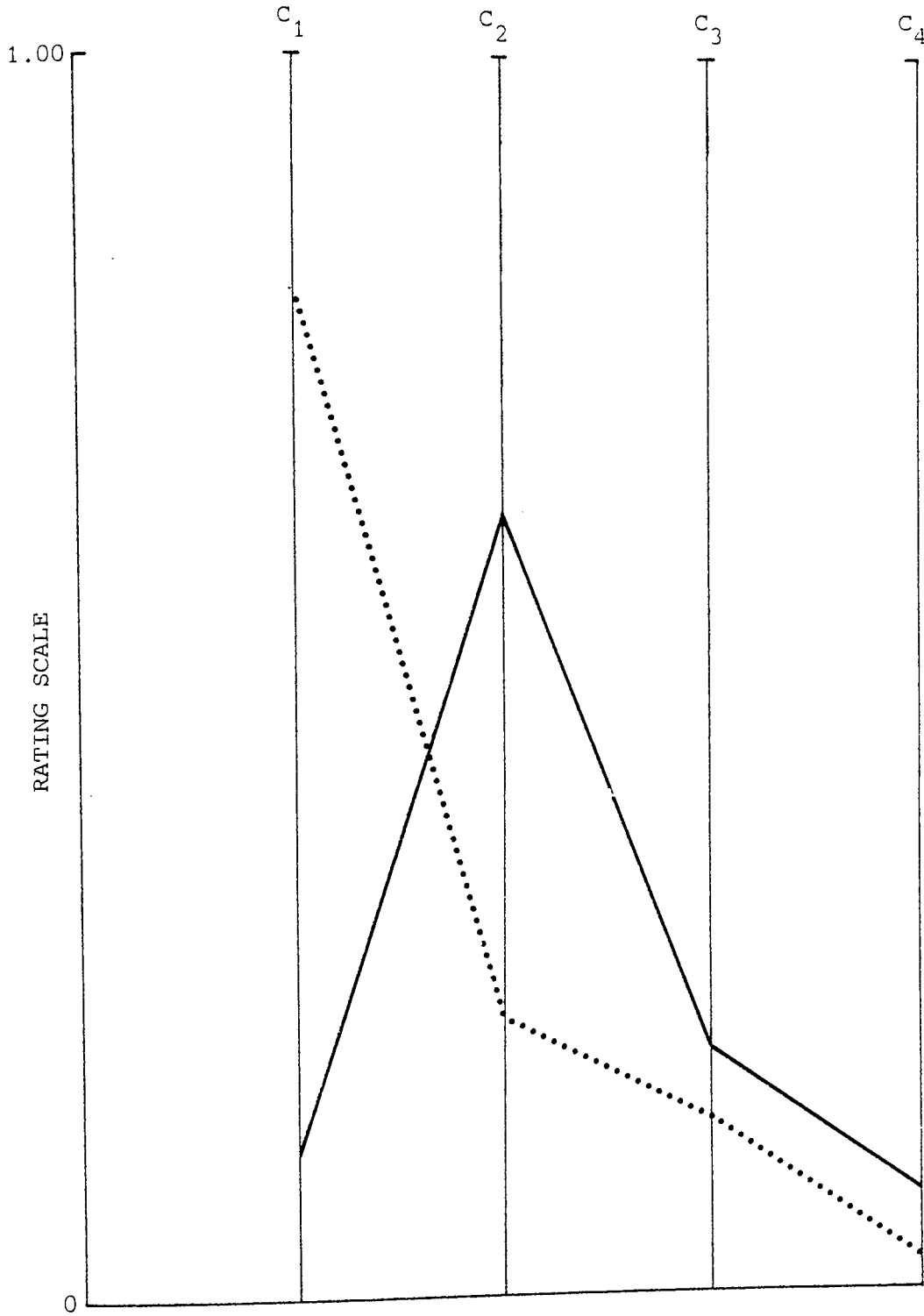
subtraction constituting its columns, which could serve as a basis for the initiation of discussions, interactions and expert advice, aimed at resolving or narrowing these differences. However, the real value of the process is envisaged to be the communication of the organisational ethos and goals (assumed to be reflected by the Arbiters) to the various levels of the organisation, as well as the enhancement of the awareness of the Arbiters, and other actors, of each other's attitudes, aims and concerns. This will enhance learning and increase organisational cohesion - a term used by Beer (1979).

The differences and discrepancies between the actors, as reflected by the differences matrix, will mainly be due to their ratings of the importance of the criteria as related to the focus of the decision situation. This is because it is assumed that options impacts on the criteria, derived from the ratio and judgemental matrices, will raise no basic disagreements and differences between the actors since a high element of expertise and knowledge is included in their evaluation process. However, the pairwise comparison between the criteria are based on the actors' judgements and concerns which are goal related, objective motivated and directly related to the actors' responsibilities - as discussed in detail in chapter 3. These may, in some cases, be irreconcilable. Hence, it may be advantageous to display the weights given by each actor (obtained directly from the criteria ranking vectors) to each criterion graphically and produce a profile of concern for each actor.

Fig 5.4 shows a simple graphical representation of this profile, where the vertical lines represent the criteria and the concern profile of each actor may be produced by plotting the weights he envisages for each criterion on the vertical criteria lines according to a 0-1.0 scale; a similar graphical representation for options evaluation was adopted by Belton (1985).

An important part of the discussion and interaction process, prior to a final decision, is assumed to be sensitivity analysis, which is based on varying the

CRITERIA



Key: — Actor (1) Profile; Actor (2) Profile.

Note: Sum of Criteria Weights for Each Actor = 1.00

Fig 5.4: Graphical Representation of Actors' Ratings of Criteria

relative weights of the criteria and analysing changes in the resultant rankings. The sensitivity analysis should concentrate on varying the weights of criteria that display large differences in rankings among the actors, this will help to concentrate efforts to resolve differences among the actors.

If the Arbiters' perception of the relative importance of the actors to the decision situation could be solicited and structured in a pairwise comparison matrix, then the resultant "importance" vector could be used to obtain the final rankings of the options by simply multiplying the actors' importance vector by the options ranking vectors of the actors. However, in the real world, it may be very difficult to solicit these actors ratings from the Arbiters, since issues of morale, confidentiality and ethics could arise that may prove insurmountable. However, fictitious weighing of actors importance may be used as part of the sensitivity analysis of the process.

Fig 5.5 outlines the steps and processes of the options evaluation and selection phases, many of the feedback iterations have been omitted for the sake of clarity.

5.4 IMPLEMENTATION - ISSUES AND POSSIBILITIES

Successful implementation of any proposed decision making methodology, in any organisational context, cannot be achieved without the backing and support of top management, assumed here to be the Arbiters, and the cooperation and consent of the actual participants in the process, assumed here to be the Planners, Implementors and the Operators. The factors which may affect the backing of the Arbiters and the cooperation of the other actors in technological choice situations in a developing environment may be categorised into:

- Cultural.
- Organisational.
- Informational.

These factors will be discussed briefly in turn.

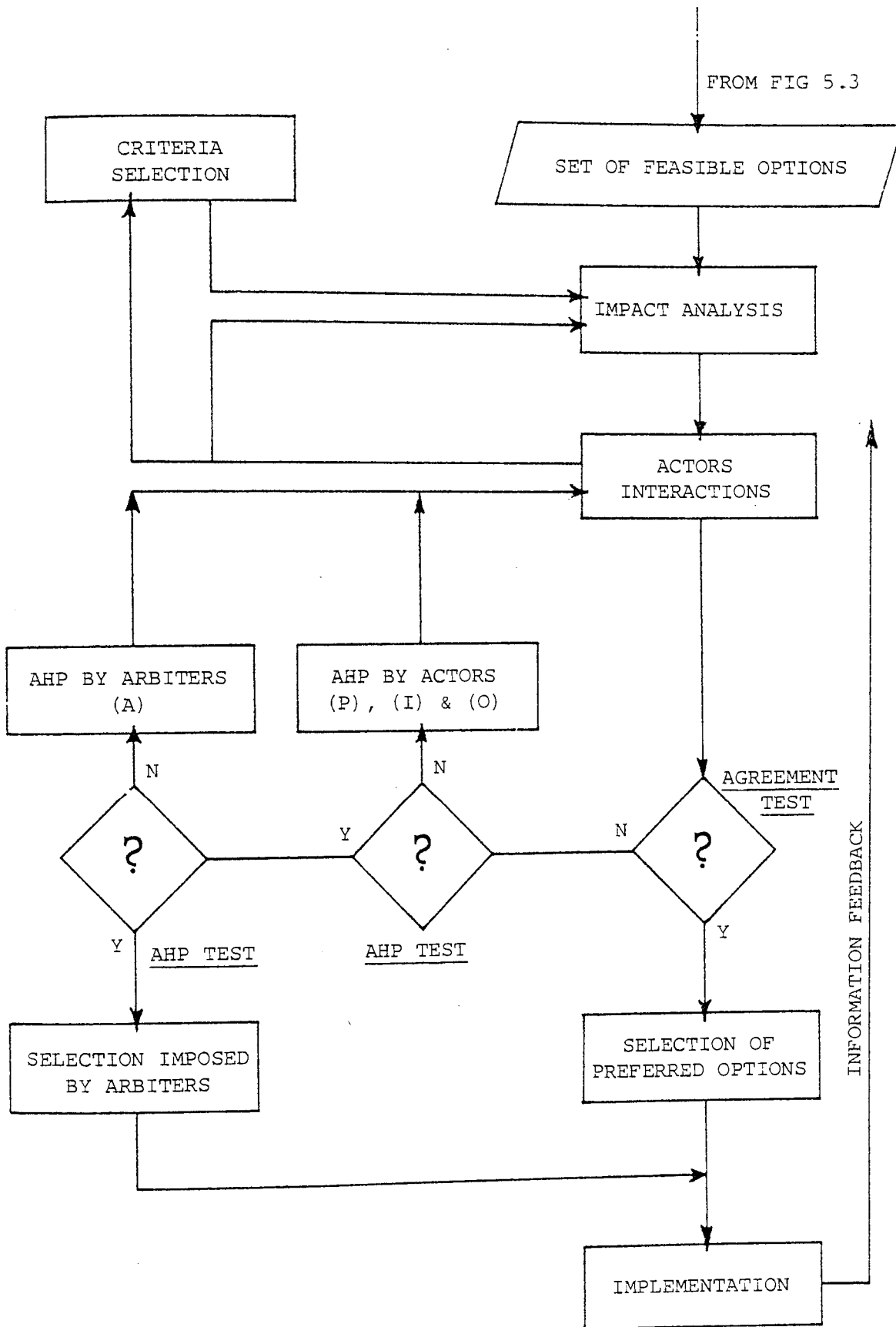


Fig 5.5: The Options Evaluation and Selection Phases

5.4.1 The Cultural Factors: These concern the decision styles and attitudes of decision makers in the developing countries. The methodology assumed a decision making culture that; encourages openness and interactions; and allows a high degree of participation of the relevant actors. However, these assumptions may run counter to the autocratic attitudes of the central bodies, especially in a centrally planned environment. Nevertheless, the methodology's systematic structuring of the decision making situation and the simplicity of its structuring and ranking processes will result in the reduction of dependence of the actors on the technical experts and will make it possible for them to make enlightened decisions that can be justified on the basis that scientific approaches have been adopted for this purpose. Also, it could provide basis for the actors - especially the Planners and the Arbiters - to claim that the decisions taken were based on the participation of the principal actors and the consideration of the relevant criteria - this justification is especially important in an environment where results and performance are closely watched and scrutinized, the usual case in major technological projects.

Decision makers - especially high level ones - may find it degrading to be subjected to the pedantic task of filling in pairwise matrices. This may be overcome by the use of attractive and clear questionnaires (Saaty, 1980; Sinuany-Stern, 1984), or by the use of indirect methods to solicit judgements, based on tactful questioning and dialogue. In any case, the application of the methodology is not envisaged to be frequent, but confined only to major and vital decision situations. This exclusiveness, added to the advantages mentioned above, may result in the enthusiastic adoption of the methodology, when the situation demands it.

5.4.2 The Organisational Factors: These concern the operationalisation of the methodology within an organisational context. Economists and accountants

have succeeded in operationalising the economic evaluation process in diverse organisational settings, including public and private organisations, in developing countries; indeed the ability to analyse and use the results of these evaluations has become part of the required general management skills (Little & Mirrlees, 1979; Lal, 1980). By the same token, the AHP based decision making process may be instilled as part of the project planning and implementation cycle; this task becomes easier in centrally planned and controlled environments due to the high levels of discipline and control, and to the ability of higher management to achieve high level of adherence from the various organisational entities under its control (Constable, 1985), hence if higher management is convinced of the methodology's usefulness, then it would not be difficult to ensure its adoption.

The organisations that are responsible for major technological projects usually have the inhouse capability (and/or the necessary access to consultants) to initiate and conduct the process involved in the implementation of the methodology, and it is envisaged that these tasks will be made even easier by the recent advances and diffusion of information technology.

The inclusion of all the principal actors in the process of decision making may be resisted by the planners, who usually enjoy privileged positions of authority during the planning and implementation stages. This resistance may be overcome by the awareness of the Arbiters that the inclusion of other actors, especially the Operators, will ensure that decisions are taken on the basis of their impacts on the whole project's life cycle and not just on its execution stages. This awareness of the Arbiters is envisaged to increase dramatically when the rankings and concerns of the principal actors are presented to them in a structured and systematic way, as stipulated by the methodology.

5.4.3 The Informational Factors: These concern the informational requirements of the methodology. Developing countries in general suffer from

inherent weaknesses in their information systems (Rosenhead, 1980b). Hence, important criteria are frequently ignored because of the dearth of information available for their proper consideration and evaluation.

The dependence of the methodology on judgemental pairwise comparison matrices adopting the 1-9 scale for measurement will facilitate the consideration of criteria that are difficult to measure or quantify. This will enable enlightened decision making with a much reduced level of factual information. The methodology will also facilitate the identification of areas where more information is required, hence enabling concentration of effort and resources.

It could be argued that the proposed methodology inherently suffers from combinatorial problems, especially in the option generation phase, but in the real life context of technological projects, this problem will be reduced, due to the following reasons:

- (1) A small number of major decision areas is involved.
- (2) A small number of salient variables is considered.
- (3) The variables will have a small number of distinct states (continuous variables may be treated as discrete by specifying ranges).
- (4) There is a high ratio of elimination of states of variables, and their combinations, due to obvious incompatibilities and infeasibilities, especially at the early stages of option generation.
- (5) The number of relevant criteria, on which the options display significant impacts, is usually small.

Finally, the proposed methodology does not aim to make decisions on behalf of the decision makers but, it will outline to the decision makers their differences and the range of the judgements they have exhibited, hence facilitating higher awareness and enhancing wider interactions. The informational requirements for transmitting and displaying this information are very basic and they could be greatly enhanced by the adoption of modern information technology.

The main purpose of the proposed methodology is the integration of the consideration of the relevant criteria in the decision making process. It was basically formulated to answer the question: How can we integrate the consideration of the manpower criterion in the decision making process of technological projects? Having formulated the methodology, it will be appropriate to investigate in more detail the manpower dimension of the decision making process and appraise the contribution the methodology could make to its proper consideration. This will be the topic of the next chapter.

CHAPTER 6

THE MANPOWER DIMENSION

6.1 INTRODUCTION

The manpower resource, as an input to any production or manufacturing process, is a very special resource. Hughes (1971) stated that:

"Manpower is a resource which has a will of its own, both individually and collectively."

Smith (1971) elaborated its special characteristics, thus:

"Manpower cannot be treated simply as one resource contributing to the economy and the efficiency of the system. It is a very special resource which can change its nature when circumstances change, in a manner not shared by an inanimate resource. It can strike, increase or decrease productivity, migrate and transfer".

Stainer (1971) highlighted the importance of the manpower resource, as related to other resources, thus:

"Manpower, to a considerable extent, determines the productivity of capital or of any other input factor."

The importance of the manpower resource, in any context, stems from the fact that it contributes considerably to the creation and the utilization of capital and other resources. It also decides how capital and other resources shall be allocated and hence is responsible directly for the efficiency of the results. Yet, inspite of this importance, very few attempts have been made to clarify the role of the manpower resource in the strategic decision making process, with the result that, too often, important decisions are based on subjective opinions and intuitions and few manpower facts (I.M.S., 1982). The exclusion of the manpower resource from the strategic decision making process is more profound in the developing countries. This is mainly due to the weakness of the information systems; to the difficulties inherent in estimating the supply of and demand for manpower; to the preoccupation of decision makers with monetary and quantifiable factors; and to the fact that the manpower factor mainly comes into effect after the completion of projects and not during their planning and implementation stages.

This chapter is devoted to the integration of the manpower resource into the decision making process throughout the project's planning and implementation

cycle, from its inception to its completion. This integration is based on treating the manpower resource as one of the principal criteria according to which options are filtered, evaluated and selected. The integrative methodology outlined in chapter 5 will be analysed as to its contribution in integrating the manpower criterion in the decision making process, and the process involved in applying the integrative methodology to manpower will be outlined and its principal features elaborated.

Section 2 is devoted to a brief review of the literature of manpower planning - the models, the techniques and the approaches - and the evaluation of the possible contributions they could make to the principal aim of integrating the manpower criterion in strategic decision making in the specified context (of technological projects in developing environments).

Section 3 is devoted to the analysis of the role played by the manpower criterion in the decision making process of the specified context, and the mapping of the manpower considerations on the elements of the project's planning and implementation systems.

Section 4 maps the manpower criterion on the proposed integrative methodology and outlines a process to ensure its smooth integration.

Sections 5 and 6 discuss some important strategic considerations and issues which may arise from the process of the integration of the manpower resource in the decision making process of technological projects in developing countries.

6.2 MANPOWER IN PLANNING - AN OVERVIEW

Purkiss (1981) enumerated four obstacles to the inclusion of manpower inputs in the preparation of business plans; they are:


Aston University

Content has been removed for copyright reasons



Aston University

Content has been removed for copyright reasons

Nevertheless, some authors have attempted to prescribe approaches that will ensure the consideration of the manpower resource in the strategic decision making and planning processes e.g. Kelleher & Cotter (1982) presented a process-oriented conceptual model and the corresponding statistical methodology needed to integrate the manpower resource with strategic business planning; the I.M.S. (1982) related manpower to the organisation's objectives and strategic decision making by adopting various ratios (involving manpower) to ascertain the required performance. However, the bulk of the work in the manpower area has been concentrated on the translation of business plans (after their formulation) into a set of manpower requirements and the ways, means and strategies to meet these requirements i.e. the manpower planning stream.

Manpower planning has been described (by, for example, The Department of Employment (1974)) as a process consisting of three elements:



Aston University

Content has been removed for copyright reasons

The prediction of the demand for manpower is a very difficult task; Lawrence (1973) elaborated the reasons for these difficulties, thus:



Aston University

Content has been removed for copyright reasons

Content has been removed for copyright reasons

However, some attempts have been made to forecast the manpower demand on the national, sectoral and industry levels. Some of these adopted the labour-economics approach, which basically relates targeted outputs to productivity levels and occupational mix ratios with assumptions about behaviour, values and trends e.g. Abed & Kubursi (1981); Marzuk (1981) for actual applications, and, Silver (1983) and Hunter & Mulvey (1981) for theoretical elaboration.

Another approach is the construction of a production function, whereby output is related to factor inputs, with parameters obtained from past data (see Mangan & Silver (1983) for theoretical elaboration). Layard et al (1971) have carried an in-depth study based on this approach, in the British electrical engineering industry.

Another approach is the construction of a matrix in which the columns represent the activities and the rows, the required skills. If the matrix could be prepared for two points in time, estimates can be made of the values of row multipliers and the column multipliers that are necessary to describe the transition of the matrix overtime. These multipliers could be used to construct the matrix of the required skills. Liecester (1971) adopted this method in his forecast of the future manpower requirements of the British economy.

However, the above approaches have been criticised on many fronts. The main ones being, that:

- They only switch the problem from forecasting the manpower demand to one of forecasting the economy (Lawrence, 1973).
- Their assumptions about the future behaviour of relevant parameters are speculative and fully dependent on past data (Purkiss, 1981); with

underlying assumptions of continuity and historicism (Encel et al, 1975).

- The approaches are deterministic and take little account of the qualitative factors and imply that the underlying structure of the system will remain the same in the future (Encel et al, 1975).
- The approaches are based on the decoupling of supply and demand, although there is a lot of evidence that they affect each other (Johnstone, 1969; Hunter & Mulvey, 1981).

Thus Lawrence (1973), advocated that only short term forecasts are useful and feasible. However, Bell et al (1969) suggested that a blend of statistical analysis, management judgement, work study measurements and productivity measurements should be adopted to produce these forecasts, while Bartholomew et al (1976) suggested only statistical analysis and management judgements.

The I.M.S. have suggested a methodology which is a synthesis of the above approaches (see Bennison (1981), I.M.S. (1982) and Purkiss (1981)). They advocated two basic approaches for estimating the manpower demand, the bottom-up and the top-down forecasts. The bottom-up forecast is based on the aggregate of the organisational units assessments of the manpower required to meet the unit's objectives and targets. These forecasts often over-estimate the level of manpower needed (Purkiss, 1981). The top-down forecast is based on the relationship that exists between an organisation and its manpower requirements. This relationship is usually based on statistical measures relating manpower requirements to business parameters, such as: added value per employee; wages and salaries as a percentage of gross sales revenue; sales per employee. These forecasts often under-estimate the level of manpower needed. The I.M.S. actually suggested using the two above approaches to produce two forecasts for the manpower requirements and the gap between these two forecasts could then be used as a basis for interaction and analysis among the Planners and line-managers

to gain further insights and understanding about the relationship between manpower levels and business needs. Nevertheless, the I.M.S. still qualify the possible contribution of their methodology with the following warning (Bennison, 1981):

Aston University

Content has been removed for copyright reasons

The forecasting of the supply of manpower is mainly concerned with predicting the flows, such as recruitment and wastage, required to achieve desired stocks, hence it requires a description of the way the manpower system works, based on historical data and management knowledge (Bartholomew et al, 1976). Models for predicting the supply of manpower are much more developed and they have been extensively and widely reviewed e.g. Bartholomew et al (1976); Edwards (1983a) and (1983b); Lawrence (1973); Price (1980); Meddings (1979). The models are basically intended to determine the availability of manpower at future time. This is done by determining the flows through the sub-systems (pools, hierarchies, processes, etc). However, the prediction of future states of the manpower system is usually based on fitting trends to past flows and relevant rates (participation, transition and wastage). These models usually only describe what has happened without attempting to understand how or why (Armitage et al, 1969); although some attempts have been made to relate behavioural factors to the relevant rates e.g. to derive a survival function based on the relationship between the length of service and wastage rates (Edwards, 1983b; Lawrence, 1973). Although supply forecasting suffers from the same ailments outlined in demand forecasting - but to a lesser extent mainly because of the accumulation of historical data - nevertheless the Civil Services Department in the U.K. has extensively developed and used a multitude of manpower supply models (Hope,

1973). Supply models have also been used extensively by manpower planners in the American armed forces. The success of the application of these models in the armed forces was attributed by Grinold & Marshall (1977) to two reasons: first, the military manpower planning problems deal with a relatively stable labour force (the career military) and military requirements that can change by order of magnitude in relatively short period of time (the military decision making structure is based on the principle of central control and planning with a high degree of discipline, hence the proposed changes in stocks, flows or policies could be effectively and speedily implemented), and second, the major role played by manpower in the armed forces, which are basically manpower intensive organisations, and where the manpower costs consume the bulk of the operating budgets. Hence, the proper use of the manpower resource becomes extremely important, driving the decision makers to employ all the possible aids to achieve its proper planning and management.

The closing-the-gap element of the manpower planning system is even less developed than demand forecasting. Strategies that result from the matching of the supply of, and the demand for, manpower, are usually on a one-off basis with little consideration to the monitoring, coordination, revision and control processes involved. This is basically due to the little understanding of the factors that influence the elements of the modelling process - flows, rates, demand (Armitage, 1969), in addition to basic faults in the assumptions implicit in the formal manpower models; these faults in the assumptions were stated by Loveridge (1983) thus:

Aston University

Content has been removed for copyright reasons

The above faults and shortcomings of the manpower planning stream have driven many authors away from it. Such as Lawrence (1973) who concluded his review with the following proposition:

Aston University

Content has been removed for copyright reasons

It is this suggested richness of approach that will be adopted as the paradigm of treatment of the criterion of manpower when it is integrated in the proposed decision making methodology.

6.3 MANPOWER IN DECISION MAKING

In the context of technological projects in developing environments, the criterion of manpower in the decision making process is generally expected to play a secondary role as compared to other criteria such as cost, completion time and political factors. This low importance may be attributed to the following reasons:

(1) The overriding importance attached to some other criteria by the decision makers: In most cases, capital cost, especially in terms of its foreign currency component, represents the main stumbling block to the national development effort, hence, it assumes overriding importance in the decision making process. Exceptions to this are the Arab oil producing countries, who possess abundant capital resources and, at the same time, suffer from severe scarcities in manpower.

(2) The inherent characteristics of the manpower criterion itself: As seen above, it is very difficult to predict manpower requirements accurately, and to forecast the availability of manpower with any great precision. Manpower is

unpredictable and only gross approximations can be made to predict its flows and movements, which have high components of qualitative and behavioural aspects. For that reason, decision making based on the manpower criterion tends to be speculative and highly contentious, as compared with the perceived predictability and accuracy of estimating economic costs and completion times. Hence, decision makers find it easier to justify their decisions when they are based on quantifiable criteria.

(3) The inherent flexibility of the manpower resource; reflected in the ability of the decision makers to adopt measures and means, such as recruitments or redundancies, to adjust the stock and flows of manpower to match the required levels. Bartholomew et al (1976) elaborated this characteristics of the manpower resource, thus:

Aston University

Content has been removed for copyright reasons

This inherent flexibility may influence the decision makers to adopt the "muddling through" (Lindblom, 1965) approach and consciously leave the manpower criterion to be dealt with as the situation warrants. This approach may be adequate in an environment characterised by manpower abundance. But, in the case of manpower scarcities this approach may result in the failure of the project to achieve its objectives and targets, due to the difficulties that will be experienced in providing it with the required manpower input.

(4) The diversity in the requirements for manpower during the project's planning, implementation and operating cycle: This diversity is reflected in the types, and the number in each type, of skills required for each of the projects'

stages. If the skills were categorised as:

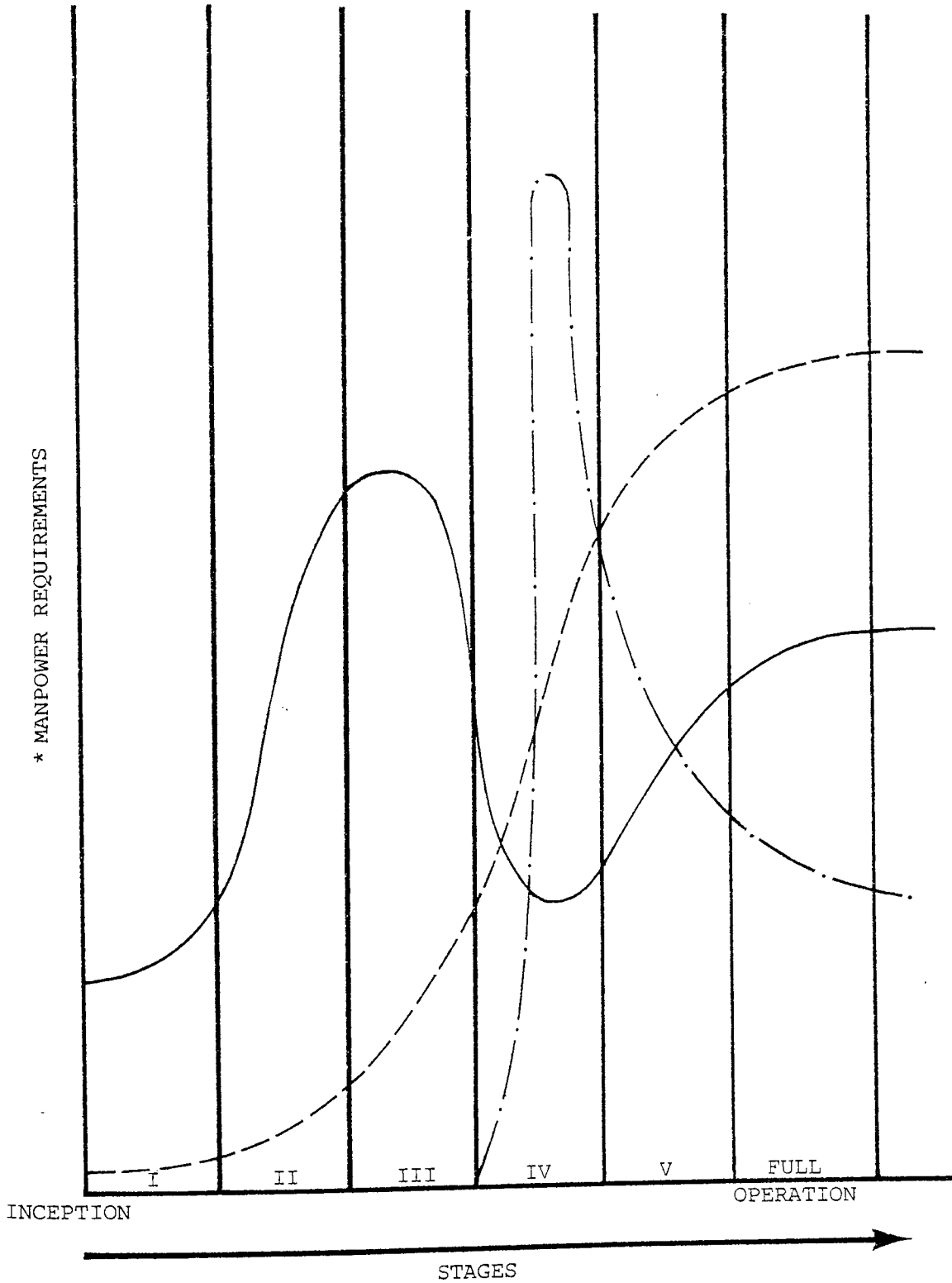
- High level (engineers, scientists, ---)
- Medium level (technicians, draughtsmen, ---)
- Low level (semi-skilled and unskilled, ---).

Then, for every project, a manpower requirements profile could be drawn, which represents, in general terms, the trend of the requirements for each skill level at each of the relevant stages (a technique adopted by Serageldin (1981a) in reflecting manpower requirements during the stages of development). Fig 6.1 shows the manpower requirement profile for a typical technological project (as related to the project's stages outlined in chapter 3). Relating the typical manpower profile of Fig 6.1 to the actors' responsibility matrix of Fig 3.4, and assuming that the actors' concerns and objectives are closely related to the stages where they have a high overall responsibility level (an assumption justified in chapter 3), then the attitudes of the relevant actors to the manpower criterion, can be analysed as follows (all assuming an environment of manpower scarcities):

Arbiters With their assumed span of responsibility for the project from its inception to its full operation, are assumed to be concerned about the project achieving its stated aims and objectives. Hence, in an environment of manpower scarcities, they should give due ranking to the manpower criterion that reflects its scarcity.

Planners Their high responsibility spans stages I - III. The manpower requirements during these stages are mainly high level and relatively small in number compared with other stages. In the case of major technological projects, the planners are usually given the authority, and the requisite priority, to obtain the required skills from in-house, internal and, if necessary, external sources. Hence, the manpower criterion tends to assume less importance to the planners than, for example costs and completion time.

LEGEND: — High level manpower
 - - - Medium level manpower
 - · - Low level manpower



Note: * Scale reflects general trends and not relative values.

Fig 6.1: Manpower Profile for a Typical Technological Project

Implementors: Their high responsibility spans stages III - IV. The manpower requirements are the biggest during these stages, especially for medium and low level skills. In the case of major technological projects, the implementors are usually allowed to import the required skills - if the local market cannot supply them. Hence, the manpower impact on the Implementors is usually transferred in terms of labour costs of the implementation stages, and if the increased labour costs are acceptable to the Planners and Arbiters, then the manpower criterion loses its importance to the Implementors.

Operators: Their high responsibility spans the "completion" and the "operating" stages. The Operators have to prepare and train the manpower required for the permanent operation of the project. Their ability to do that is usually restricted by policies, guidelines and environmental factors, and their authority to obtain the required manpower is usually much more restricted than the authorities and priorities given to the Implementors and the Planners.

Since the operators deal with the permanent phase of operation, and not with the transient phases of planning and implementation - Planners and Implementors move to other projects while Operators are stuck with the completed ones - and since the manpower component is vital to the efficient and successful operation of any technological enterprise, hence, the manpower criterion assumes vital importance to the Operators in an environment of manpower scarcities.

In conclusion the diversity in the requirement of manpower during the project's stages will result in different attitudes by the Actors towards the manpower criterion, and since the prevalent decision processes give much higher weights to the Planners and Implementors, mainly because of the pressure to

complete the projects, hence, the manpower criterion may be given less than its due weight in decision making.

The integrative methodology was formulated for the purpose of integrating the relevant criteria (including manpower) in the decision making process. Therefore, it is appropriate to outline the possible application of the methodology as it is related to the manpower criterion.

6.4 THE INTEGRATION OF MANPOWER

The outline of the tasks and processes involved in the integration of the manpower criterion within the proposed methodology, in the decision making context of technological development projects, will be elaborated by following the classification of phases adopted in the methodology and outlining the role, impact and relevance of the manpower criterion in each of the phases. This will be done in turn.

6.4.1 The Options Generation Phase: The consideration of the manpower criterion, like other criteria, should be excluded from the "Amplification" step, since "Amplification" should be conducted with total exclusion of any constraint. This may prove difficult in cases of acute manpower scarcities, since some of the options may be excluded due to implicit assumptions by the experts and analysts. However, it is a prerequisite for options richness that the step should be constraint free.

In the "Attenuation" step, the main difficulty lies with the inclusion of the manpower criterion. Since, manpower is the main concern of the Operators, it may prove very difficult for them to influence the other actors to give manpower its due consideration. However, if the integration paradigm is instilled enough in the decision making process and seriously adopted by the Arbiters, enough

pressure should be generated to force its inclusion. At this stage, it is envisaged that only general analysis of the options, as to their manpower requirements, need be carried with general indications about the order of magnitude of the number of skills, their type and general characteristics provided. These requirements are then to be assessed by the actors as to their policy implications; as to their relationships to thresholds and manpower constraints; and as to their effect on the present sector. From this assessment, indications as to possible manpower policy adjustments, manpower factors (such as rates and flows) modifications and manpower systems effects, may emerge, which could serve to improve the responsiveness of the manpower systems and its related factors. The manpower information and analysis required for this assessment could be provided, for the relevant actors, by the operating organisation's personnel and planning functions tapping on information provided, and updated, by the sectoral and national planning and personnel organisations. However, the quality and extent of the supplied information and analysis vary widely from one environment to another, but even in the weak informational environments of the developing countries, the attenuation of the options could be conducted by referring to the important and well known manpower policies and guidelines, which should be familiar especially in centrally controlled and disciplined environment; by applying the actors' impressions about the states of the environmental and systems factors; and by adopting the operating organisation's perceptions about the abundance/scarcities of the relevant skills, which should be based on enlightened impressions about the national, sectoral and organisational manpower scene. However, the adoption and the application of the methodology could serve as an impetus for the improvement of the manpower information system so that the subsequent attenuations of options will be conducted against a better level of relevant information.

It is not anticipated that the manpower criterion will cause the deletion of many options at this stage, but the systematic consideration of it will ensure that,

if there is a major manpower obstacle for the further consideration of the option, then either the option is deleted at this early stage of the decision making process, or the obstacle is removed via policy and/or other factors adjustments.

6.4.2 The Options Evaluation Phase: The detailed consideration of the manpower criterion in the evaluation phase may prove difficult since it is only the Operators who, usually, give it its due importance, and they are usually on the fringes of the decision making process during the planning and implementations cycle of the projects. However, the adoption of the systems approach in general, and the integrative methodology in particular, augmented by the proper backing of the Arbiters for integrative decision making processes, should remove these obstacles and should ensure the inclusion of the manpower criterion. Also, analysts and experts may argue that the manpower costs are already included in the economic evaluation. But, this is totally inadequate since; the manpower costs are usually calculated based on rule-of-the-thumb ratios e.g. maintenance cost (including manpower) is assumed to be 10% of the original capital cost per year; the manpower costs are usually computed on the basis of prices and ratios prevalent in the originating industrialised countries and they do not actually reflect the manpower environment of the developing country; and, manpower should not always be treated as a cost, indeed in most developing countries, it is an asset to the project if it employs a high number of people.

The analysts and/or consultants (who, are assumed, to carry out the detailed analysis of the impact of the feasible options on the relevant criteria) may find it very difficult to estimate the manpower implications of each option due to the inherent difficulties of manpower forecasting and possible non-familiarity with the manpower environment and system. Also, various interests within a particular actor group, may make it impossible to agree on manpower impact figures; this in addition to the expected disagreement between the groups

themselves. For these reasons, it is suggested that the analysts and/or consultants, may coordinate the following procedure:

(1) Construct a hierarchy of three levels: The first, is the focus which, in situations of manpower scarcities, may be labelled as "the minimising of the manpower cost", and, in situations of manpower abundance, may be labelled as "the maximization of the manpower contribution". The second, contains the relevant skills, which are; in situations of manpower scarcities, the ones which are most difficult to supply from the available sources at the organisational, sectoral and national levels; and, in situations of manpower abundance, the ones which the organisation is under pressure to employ. The third, contains the feasible options.

(2) Perform the AHP; to construct pairwise matrices for each of the relevant actors. The pairwise matrices comparing the manpower impact of the options, for each of the relevant skills, may be based on actual demand figures if they could be estimated accurately and their values are agreed by the various interests within the individual actors groups. However, it is envisaged that, in most cases, the matrices representing the actors could only be constructed by using the 1-9 scale; since it is easier to achieve agreements about levels of dominance and trends of values than consensus about actual quantities. The pairwise matrices comparing the levels of difficulty (or ease) of obtaining the required units of the relevant skills, may be based, on the 1-9 scales with background information about the estimated shortfall (demand-supply), for each of the relevant skills, at the organisational, sectoral and national levels, in case of skill scarcities and the estimated abundance (supply-demand) in case of skill abundance (possible matrix entries, in case of skill scarcities, may be the number of non-nationals with that skill working in the country). If this type of

information is not available, as expected in most developing environments, then the process has to be conducted initially with the assistance of general comments and impressions about the availability, or otherwise, of the relevant skills provided mainly by the planning and personnel functions at the three levels - organisational, sectoral and national. However, the informational demands of this process should again act as an impetus for these departments to channel their efforts to satisfy these demands in the future.

(3) Perform the process outlined in the proposed integrative methodology; to integrate the consideration of the manpower criterion with other relevant criteria and the deduction of the options and criteria ranking vectors for each of the relevant actors (as outlined in chapter 5).

6.4.3 The Options Selection Phase: The actors' ranking vectors will reveal the impacts of the options on the criteria and the actors' rating of the criteria. This information should ensure that a criterion as important as manpower will not be overlooked or scantily regarded in the decision making process. The vectors rankings may trigger an interaction and discussion effort among the actors that will enrich decision making and increase their appreciation of each other's concerns and standpoints. They may also trigger a research and information gathering effort that should result in better and more informed judgements and more enlightened decision making. However, the greatest contribution is envisaged to be the resultant awareness at the various levels of the organisational hierarchy of the manpower impact of any major technological decision, at an early stage of the decision making process. This will enable the decision makers to initiate policies, strategies and guidelines that will ensure the smoothest possible implementation and operation of the project.

Fig 6.2 is an attempt to relate the consideration of the manpower resource to the proposed decision making methodology and to the manpower planning systems at the organisational, sectoral and national levels. It is intended to integrate the processes, interactions and relationships outlined in this section, with feedback and iterations kept to the minimum for the sake of clarity. The figure depicts the relationships and interactions prevalent in a typical public sector within a centrally planned developing environment. The richness and extent of the information flow and exchange between the various levels are highly context specific and vary from country to country, but they are generally at an early stage of development in the developing countries.

6.5 INFORMATIONAL ISSUES

Developing countries usually suffer from inherent weaknesses in their information system. This makes any process, that requires detailed input and is required to produce prediction of great precision, very difficult to apply in a developing environment. The procedure for integrating the manpower criterion in the decision making process is meant to be especially suitable for the developing countries. This is because; it adopts the AHP with its dependence on judgemental, instead of quantitative, scales; and the possibility of implementing the procedure on the basis of the actors' experience, impressions and perceptions instead of detailed data and facts. It is also envisaged that the adoption of the procedure will help to structure priorities for data acquisition, making better information available for subsequent planning cycle.

Although it has been suggested that the methodology could be initially applied in environments characterised by informational weaknesses, nevertheless, its adoption should provide a strong incentive to pursue the development of a strong manpower information and planning systems that will facilitate its proper and efficient implementation. In a centrally planned developing environment an

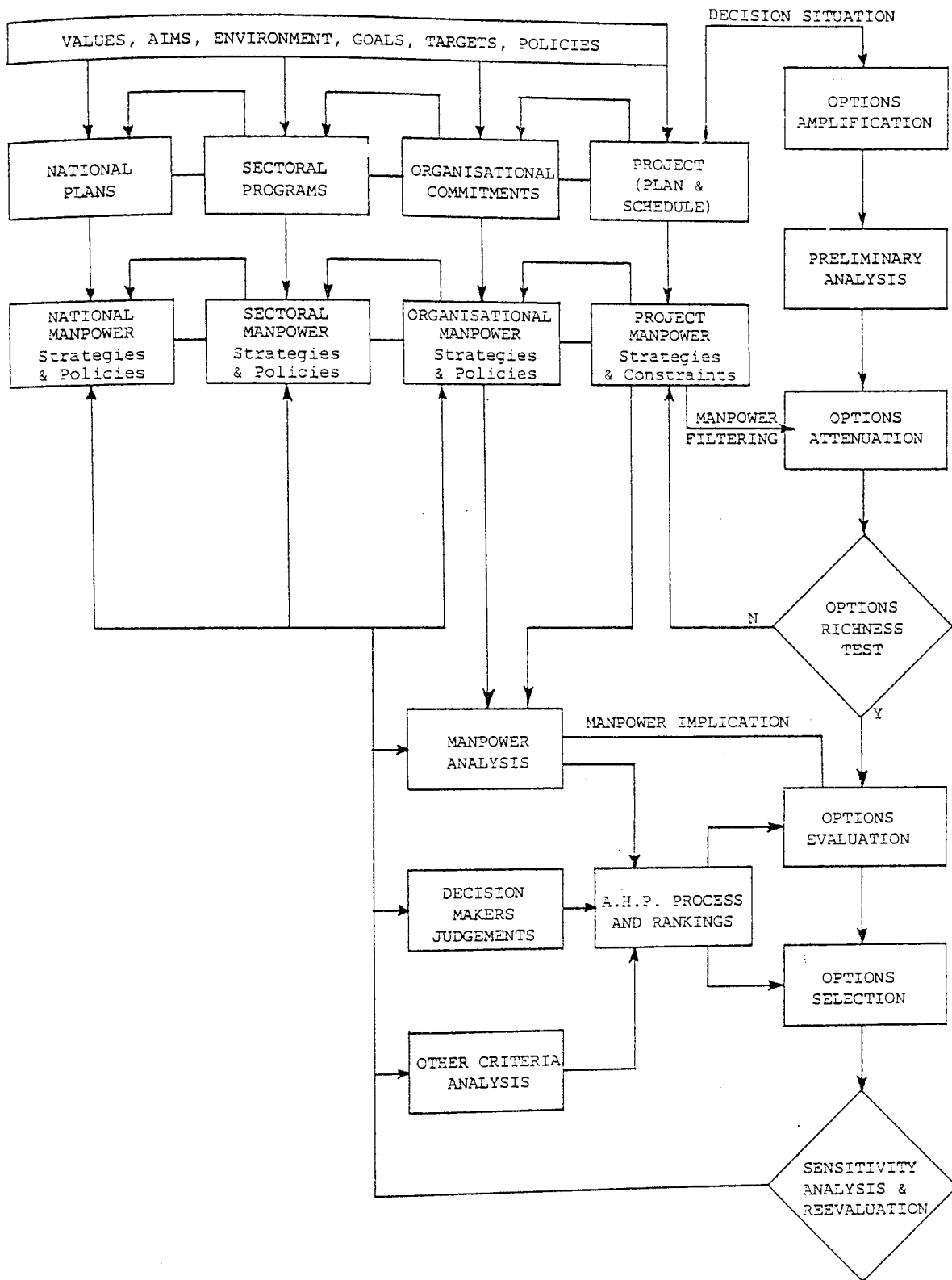


Fig 6.2: Integration of the Manpower Criterion in the Projects' Decision Making Process

"ideal" manpower planning and information system will perform the following manpower related tasks, with their resultant information and analysis, and distribute the results efficiently among the relevant actors prior to the application of the methodology.

- (1) The full consideration of the manpower implications of the development plans at the national, sectoral and organisation levels. Although this is a very difficult task to be performed accurately given the inherent difficulties of demand forecasting, however, general indications and trends may be ascertained using gross parameters that relate manpower to targets and objectives of the plans e.g. productivities. It is also envisaged that these manpower implications should be an integral part of the formulation of the plans and not just a result of it, hence, ensuring that the plans are practical and feasible from the manpower point of view. The plans should be accompanied by a brief about the policies, guidelines and standards that ensures their manpower feasibilities at the three levels.
- (2) The analysis of the scarcity/abundance of the relevant skills and its continuous updating; at the national level - by the Central planning agency; at the industry level - by the sectoral planning units; and, at the organisational level - by the organisation personnel planning units. These scarcities/abundance should have their values and trends estimated over the planning horizon, and these estimations should be based on feedback, interaction and information exchange between the three levels. They should be based on relating the gross demand for each skill at each level to the availabilities of these skills from the internal sources, including the education system - this method is suggested because in most developing countries, the wages and salaries paid to the skills do not accurately reflect their scarcities due to gross imperfections in the labour market.

- (3) The organisations that will operate the projects, should carry out a detailed manpower balance from which the ranges in numbers of each skill that could be allocated to the projects, be deduced. The organisation should also work out the policy implications of providing number of skills outside the specified ranges e.g. At what approximate requirement for skill x, the policy of non-import from European countries, should be relaxed?; at what requirement for skill y, the wages structure should be revised to attract the required number?; at what requirement for skill z, the abandonment of other commitment should be considered?

It is suggested that if the above planning and informational tasks have been performed, then the integrative methodology will be provided with the ideal background against which the integration of the manpower criteria may be conducted.

6.6 STRATEGIC CONSIDERATIONS

The integration of the manpower criterion in the strategic decision making is especially important in the fast-growing developing countries that adopt the comprehensive planning approach to their development. This is because public sector organisations, which are usually the major employers, are not left free to devise strategies that ensure the adequate manning of their projects - this is in contrast to the situations in the western industrialised countries and the developing countries that adopt the free market approach, where the matching of supply and demand is achieved via the control mechanisms of wages, incentives and rewards; resulting in earnings reflecting the relative scarcities of the skills (Hunter & Malvey, 1981). In this centrally controlled environment adjustments of the pull factors (such as wages) by the public sector organisation may involve wide-ranging policy and strategic ramification on the sectoral and national levels

that may prove impossible to sanction without adjustments of policies and priorities.

In centrally controlled developing environment characterised by manpower scarcities, the need for the full consideration of the manpower criterion becomes even more acute. Since, the provision of the project's required skills may not be possible within the prevailing framework of policies, guidelines and regulations. In these situations, one of the main strategies that could be adopted - and is adopted by such countries as the Arab Gulf countries - for the matching of supply and demand is the strategy of recruiting foreign skills, but this strategy is fraught with political, social, economic and even technical ramifications and shortcomings. In centrally controlled environments, this strategy may fail because of policy constraints concerning issues such as (Serageldin, 1981a)



Aston University

Content has been removed for copyright reasons

The above policies and constraints may make it impossible for the organisations to achieve the requisite manning levels for their projects. But this has to be known early in the decision making process, so that strategies may be formulated to either adjust the flow from the internal sources (the education system, the labour market, the organisation itself and its parent sector, the other sectors) to the organisation, or, to revise policies and regulations governing and controlling the flow from the foreign sources, or, by reconsideration of the projects parameters to reduce its requirements, or, by a combination of the three. The proposed methodology ensures this early treatment, and guards against the usual tendency of the consultants and analysts - who are usually from the

industrialised countries - to treat the manpower requirements as part of the overall cost criterion, based on their countries' indices of earnings and pay; and to overrate the role of the wages and incentive mechanism in the matching of supply and demand.

But, as a requirement for the integration of the manpower criterion, the concerned organisations should accumulate information, data and knowledge about the manpower sources which should include; the type and characteristics of the skills supplied by each source; the policies and factors that influence the flow of these skills from their sources to the organisation; and, the degree of control the organisations, and their parent sectors, have on each of the sources. However, the accumulation of the above information and data could proceed with the application of the manpower integration and not as a prerequisite for it, thanks to the judgemental process adopted by the methodology..

The proposed integrative methodology and the above exposition of the role of the manpower criterion, are an attempt to ensure the consideration of the manpower resource in strategic decision making in environments where manpower is a vital and scarce resource and where the environment does not allow the classical manpower control mechanisms to function i.e. fast-growing developing environments characterised by manpower scarcities.

The following chapters are devoted to the assessment of the feasibility of adopting the proposed methodology in such an environment via the analysis of a case example from the Iraqi oil industry.

CHAPTER 7

CASE EXAMPLE : THE SOUTHERN-IRAQ

LPG PROJECT

I. BACKGROUND AND ENVIRONMENT

7.1 INTRODUCTION

The previous chapters dealt with decision making within the context of the general environment of technological projects in developing countries. This environment was outlined in chapters 2 and 3, and the need was established for a methodology which aims to integrate the consideration of the relevant criteria in the decision making process. The methods, techniques and issues related to the field of multiple-criteria decision making were reviewed in chapter 4 to ascertain their relevance and suitability for the proposed methodology. Chapter 5 was devoted to the outline of the integrative methodology, which is proposed to be applicable to the general situation outlined, utilizing a synthesis of the established methods of MCDM. Chapter 6 was devoted to the analysis of approaches and methods as to their suitability to deal with the important criterion of manpower within the integrative methodology.

However, the applicability, validity and feasibility of the integrative methodology have to be assessed within a specific developing environment. The Iraqi oil industry was chosen for this purpose and a large technological project - The Southern-Iraq LPG Project - was singled out as the specific technological environment within which the feasibility of the integrative methodology will be assessed.

This chapter is devoted to the outline of the decision making environment enveloping the LPG project, and to the analysis of the planning cycles (process and levels) and the prevalent decision making system (components, roles and boundaries) that is steering the project from conception to completion.

The chapter will serve as a background to the task of assessing the feasibility of the application of the integrative methodology to a technology choice situation within the context of this project - the subject of the following chapter (8).

Section 2 will cover the logistics, aims and methods of the field investigation.

Section 3 will outline the decision making environment enveloping the LPG project on the national and sectoral levels with particular emphasis on the policies and allocation processes of the manpower resource.

Section 4 will concentrate on outlining the general background and characteristics of the LPG project, with special emphasis on analysing the roles and responsibilities of the relevant actors and relating it to their concerns and objectives.

7.2 THE FIELD INVESTIGATION

7.2.1 Aims and Objectives: The principal goal of the field investigation is the assessment of the feasibility and the validity of the proposed integrative methodology. This is to be achieved by the detailed examination of a suitable case example within a centrally planned developing environment, whereby the examination is set to accomplish the following specific aims:

- (1) To establish the need for a structured integrative decision methodology in a technologically developing environment that typifies the context outlined in the formulation of the proposed methodology.
- (2) To establish the principal characteristics of, and the assumptions that should underly, a feasible and potentially useful integrative methodology for real life technological decision making. These assumptions and characteristics are then to be utilized for the refinement of the proposed methodology to enhance its applicability in real life situations.
- (3) To examine in detail a specific technological choice situation within the context of a large development project. This examination will concentrate on the decision processes involved, the prevalent influencing factors and the roles of, and interaction between, the

elements of the choice situation (with special emphasis on the manpower criterion). The purpose is to outline the possible contribution of the proposed methodology in improving the quality of decision making and to identify the requirements and processes that could facilitate the application of the methodology in the specific case example. It is hoped that this examination would be used as a basis to draw some principles for the adaptation of the methodology for the general context of technological development.

7.2.2 Choice, Logistics and Methods: To achieve the above aims a case example within the Iraqi oil sector was chosen, namely - the Southern-Iraq LPG Project (from now on the LPG project). The main reasons for this choice are as follows:

- (1) Iraq is an oil-producing developing country, which has been witnessing very rapid development since 1973. It adopts the form of central comprehensive planning to steer this development and suffers from the constraint of manpower scarcity as the main obstacle for the implementation of its development plans (A.B.S.P., 1982). Hence, the Iraqi environment contains the principal features of the context upon which the formulation of the methodology was originally based.
- (2) The author has worked in the Iraqi oil sector for thirteen years prior to his sponsorship by the Ministry of Oil to study for a doctorate on study-leave basis. During this period he has advanced from the position of Assistant Electrical Engineer to the headship of the Electrical Engineering Department in the Southern Petroleum Organisation (hereafter SPO) of the Iraqi National Oil Company (hereafter I.N.O.C.), a position he held for the last four years before coming to study in the U.K. This has ensured that the author will

receive good access to people, places and information, and to obtain the cooperation and help of vital personnel at various levels within the organisations that constitute the oil sector.

- (3) The long experience of the author in the Iraqi oil sector and his long service within the SPO in Basrah, Iraq has made him quite familiar with the prevailing decision processes and systems. This has ensured that the time devoted to the investigation will be spent on relevant issues and factors and not on familiarization.
- (4) The LPG project is a very large and complex project, its planning and implementation were started in 1978 and were not yet fully completed at the end of 1984. The author has actually participated in some of the project's technological decision making over the period 1978-1980. Hence, it is an ongoing and familiar project involving multiple and multi-faceted technological choice situations. This ensures that the processes and factors investigated are both relevant and contemporary.

The field investigation was conducted over the period November 1983 - January 1984 and was sponsored by the Ministry of Oil, with the General Establishment for Oil Training (hereafter G.E.O.T.) being responsible for its supervision and administration.

The methods adopted in the investigation were:

- Interviews
- Observations
- Information and data gathering,

However, before embarking upon the details of these methods, it is necessary to outline the Iraqi organisational structure on the national and oil sector levels. These structures, shown as organisational charts (Figures 7.1 and

7.2) with particular emphasis on the organisations that are relevant to the case example, will facilitate easier identification of the people and organisations involved and better understanding of their relationships, tasks and roles. These charts will be treated as a reference throughout the analysis of the case example.

The interviews were semi-structured focus type, in that the focus and topic were decided in advance, but the questions and probes were not (Bailey, 1978).

Deep, long and wide ranging interviews were conducted with 25 middle and senior managers and engineers in the Oil Ministry, and its constituent organisations, and within the Planning Ministry and its constituent commissions.

To preserve the anonymity of the interviewees, a system of coding will be adopted which is based on the organisations that the interviewees belong to. The functions of the officials who were interviewed, their organisations and their respective codes are shown in Table 7.1 (reference should be made to the codes outlined in this table when details of the interviewees are sought after).

The observations were based on the presence of the author during planning and decision making sessions, mainly within the SPO - Basrah, INOC - Baghdad and the State Company for the Construction of Oil projects - Baghdad. Some of these sessions were exclusive to the managers and engineers of the particular organisation, while others had representatives from other related organisations within the sector.

The information and data gathering were based on personal and official contacts between the author and the various officials within the relevant organisations. Reports, data, statistics and information were made available to the author by all the organisations contacted, especially the Central Statistics

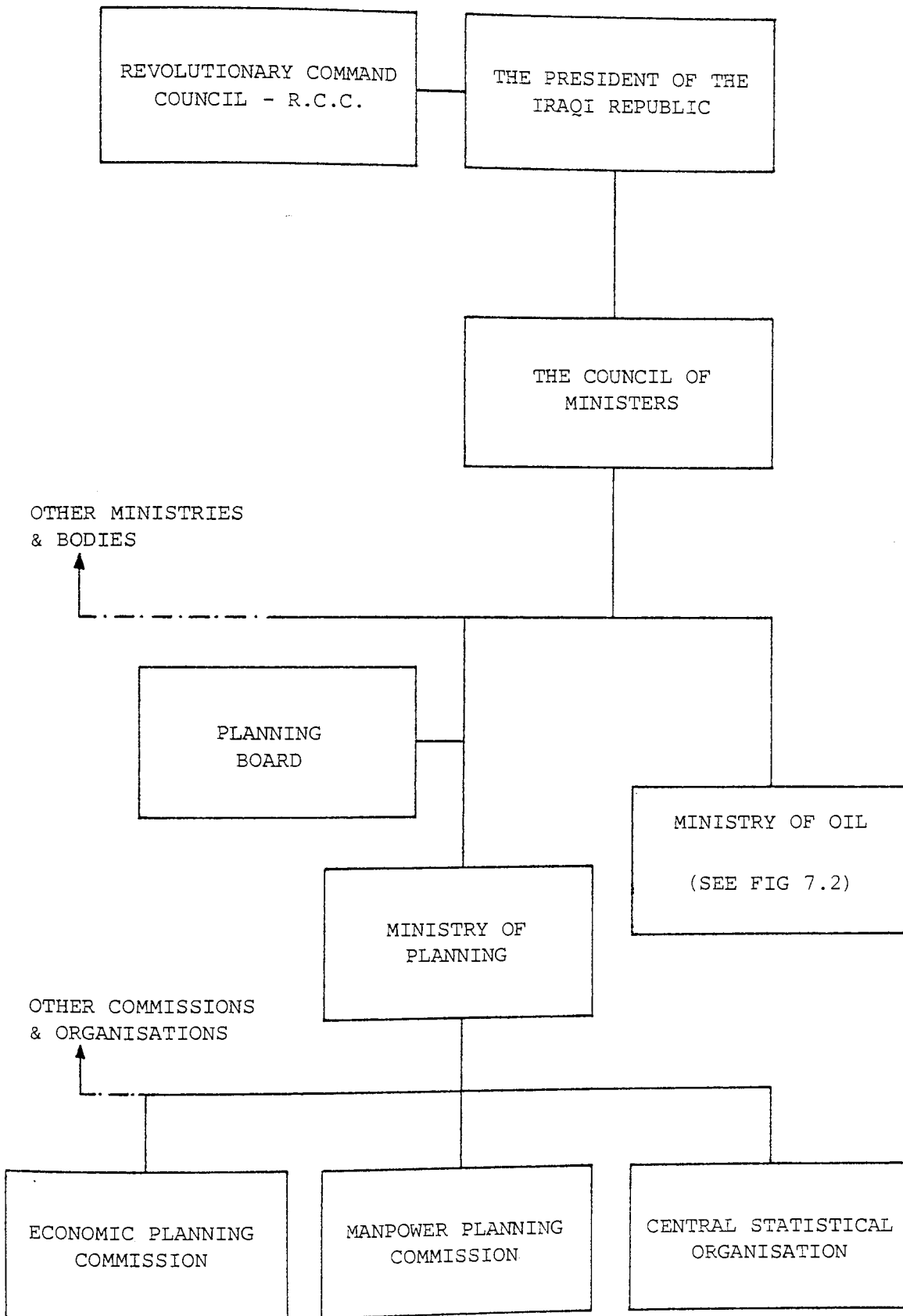


Fig 7.1: The Iraqi National Organisational Chart



Aston University

Illustration has been removed for copyright restrictions

Fig 7.2: Iraqi Ministry of Oil - Organisational Structure (1984)

| FUNCTION ORGANISATION | DIRECTOR GENERALS D.G. | HEADS OF FUNCTIONAL DEPARTMENTS | PROJECT LEADERS AND MANAGERS | EXPERTS ANALYSTS & ENGINEERS |
|--|------------------------------|---------------------------------------|------------------------------------|------------------------------------|
| Ministry of Oil * | PSF 1 | | | PSF 2, PSF 3 |
| Southern Pet. Organisation (SPO) | SPO 4, SPO 5 | SPO 1, SPO 2 | SPO 3 | |
| State Company for Construction of Oil Projects (SCCOP) | | | SCCOP 1, SCCOP 2, SCCOP 3 | SCCOP 4, SCCOP 5, SCCOP 6 |
| Iraqi National Oil Company (INOC) | INOC 4, INOC 5 | | INOC 1, INOC 2 | INOC 3 |
| General Establishment for Oil Training (GEOT) | | GEOT 1, GEOT 2 | | GEOT 3 |
| Ministry of Planning ** | MP 1 | MP 2 | | MP 3 |

Notes: * All interviewees belong to the D.G. for Planning, Studies and Follow-up.

** Interviewees belong to the Commissions of Manpower and Economic Planning.

Table 7.1: Organisations, Functions and Codes of the Interviewees

Organisation - Ministry of Planning, the technical divisions within the SPO - Basrah & INOC - Baghdad, and the planning sections within G.E.O.T. - Baghdad.

7.2.3 Limitations and Constraints: The investigation suffered mainly from the fact that Iraq is in a state of war with Iran, and has been ever since September 1980. This has resulted in an atmosphere of higher levels of secrecy and control of information than usually encountered. Reports, data and information that were openly circulated before the war are now classified, and interviewees were rather more guarded in divulging important information. However, it must be stated that in spite of all this atmosphere, the author was given the maximum possible access to information and data and unlimited time and attention by all the officials, at all levels, that he had interviewed.

The other main constraint concerns the nature of the investigation itself, with its emphasis on assessing the feasibility of the proposed methodology within a given environment. This necessitated the adoption of semi-structured interviews as the principal method of investigation, with all its resultant difficulties of conduct, interpretation and analysis. These interviews had all to be conducted by the author, hence bringing the constraints of time limitations and monetary expenses into prominence.

Having outlined the logistics and methods of the field investigation, the following sections will be devoted to the outline of its findings and results as related to the decision making environment enveloping the LPG project.

7.3 THE ENVIRONMENT OF THE LPG PROJECT

7.3.1 The National Scene: Centralised Planning in Iraq goes back to 1950 when the Development Board was established to formulate the programmes

necessary to achieve economic development. In 1953 the Ministry of Development was established as the executive arm of the board. Prior to the revolution of 14th July 1958, development programmes were formulated on a partial basis to tackle specific economic problems (e.g. irrigation system). However, in 1959 the Development Board and the Development Ministry were abolished and replaced by the Planning Board and the Planning Ministry respectively, and the mode adopted was, "Central planning and autonomous implementation", whereby the Ministry of Planning formulates the economic development plans and the other Ministries implement the specific programmes and projects, according to their respective areas of responsibility. Over the period 1959-1968, the plans were neither comprehensive nor accurate, this was mainly because of the inherent weaknesses of the planning and statistical agencies, and the lack of prior studies and accurate statistical data. Also, the aims of these plans were not adequately achieved because of the weaknesses of the implementing ministries and agencies; the limitation of control and follow up and the chaotic political situation over this period (Ministry of Planning, 1984; Kadhim, 1974; Sabie, 1980; Ali, 1982).

After the 17th of July 1968 revolution, a strategy of fast and comprehensive development was adopted by the ruling Ba'th party. The necessary means to achieve this strategy were identified by the party, as follows (A.B.S.P., 1974):

- The replacement of improvised and fragmentary economic policies with scientific planning, based on comprehensive technical and economic studies, in order to ensure the validity of the resulting plan, then the division of these national plans into clear and detailed programmes for the producing organisations.
- The promotion of large-scale participation in planning by workers in economic sectors, and the collaboration of different organisations in the preparation of the plan and the setting up of committees to examine preparations at every stage.

- The support of the executive organisations, whether government departments, public-works enterprises or units of production, in both the public and private sectors.
- The development and support of the national and the sectoral, statistical and planning departments.
- The preparation of sound financial policies to finance the development strategy, taking into consideration the finance and technical resources of the state.

The implementation of the above tasks resulted in the formulation of two comprehensive development plans since 1968; they were:

- The national development plan 1970-1974 (Iraqi official gazette, 1970).
- The national development plan 1976-1980 (Iraqi official gazette, 1977).

Since 1981, national planning has been based on yearly investment programmes to provide the requisite flexibility required for the state of war that existed since 1980 (Ministry of Planning, 1984). These national development plans included detailed targets for the principal economic parameters, such as production, incomes, employment, consumption, savings and overseas trade. They also specified a growth rate for each of the principal sectors of the economy, together with the amounts of resources and investments required for the achievements of these targets; Table 7.2 shows the growth targets, for the principal activities, as specified by the 1970-1974 plan; and Table 7.3 shows the amount of capital allocated to the principal economic sectors in the two development plans.

The actual process of the formulation of these plans involves many loops of feedbacks and iterations. The basic skeleton of this process, and the tasks and



Aston University

Content has been removed for copyright reasons

Source: Iraqi Official Gazette (1970): Law 70 of 1970,
Ministry of Information, Baghdad, Iraq (Arabic).

Table 7.2: Growth Targets of the Third Five Year National
Development Plan 1970-1974 .

(In Thousands Iraqi Dinars - In 1975 1 I.D. = 3.37 U.S. \$)



Aston University

Content has been removed for copyright re

Notes: * Allocation for 1975 was not covered in the 1976-1980 plan, and covers only 9 months.

Sources: Ministry of Planning - Annual Abstract of Statistics 1980, Baghdad, Iraq.
Ministry of Planning - Statistical Pocket Book 1982, Baghdad, Iraq.

Table 7.3: Allocations of National Development Plans 1970-1982

roles of the various organisational levels in the plans formulation, is shown in Fig 7.3 which is based on extensive interviews and observations during the field investigation.

The process shown in Fig 7.3 requires extensive coordination and feedback between all the organisational levels. To ensure this, planning units have been created in the ministries and organisations, and functional commissions have been set up in the Ministry of Planning; the commissions are formed according to the specialization of the principal sectors and deal directly with the planning units within the respective ministries (e.g. The Commission for Manpower Planning coordinate the planning effort of the Ministries of Education and Higher Education and acts as an interface with the manpower demand centres).

The national plans produced by this process are then regarded as the basis according to which the sectors and organisations prepare their own plans and programmes, and, in the central comprehensive planning approach adopted by Iraq, the implementation of these plans is compulsory for all the organisational units in the country. To reinforce this adherence, the plans are usually published in the form of a law; flexibility is provided by the production of "Annual plans" which cater for contingencies and unforeseen variations in the environmental factors. The top political leadership and the planning agencies attach great importance to the implementation of development plans and programmes. INOC 4 reflected this when he stated:

"We are continuously reminded, indirectly by the top political leadership, and directly by our own top management, that it is imperative to achieve the targets set in the national plans. The Ministry of Planning demand from us quarterly reports detailing the progress made on the major development projects and the amount of vital resources utilized to achieve it. We are under no illusions that what has been allocated for us by the plan has to be spent and spent well, and that any allocation left unspent constitutes great waste, since in essence, we have deprived other areas from utilizing it."

Due to the high level of commitment of the political leadership, the planning

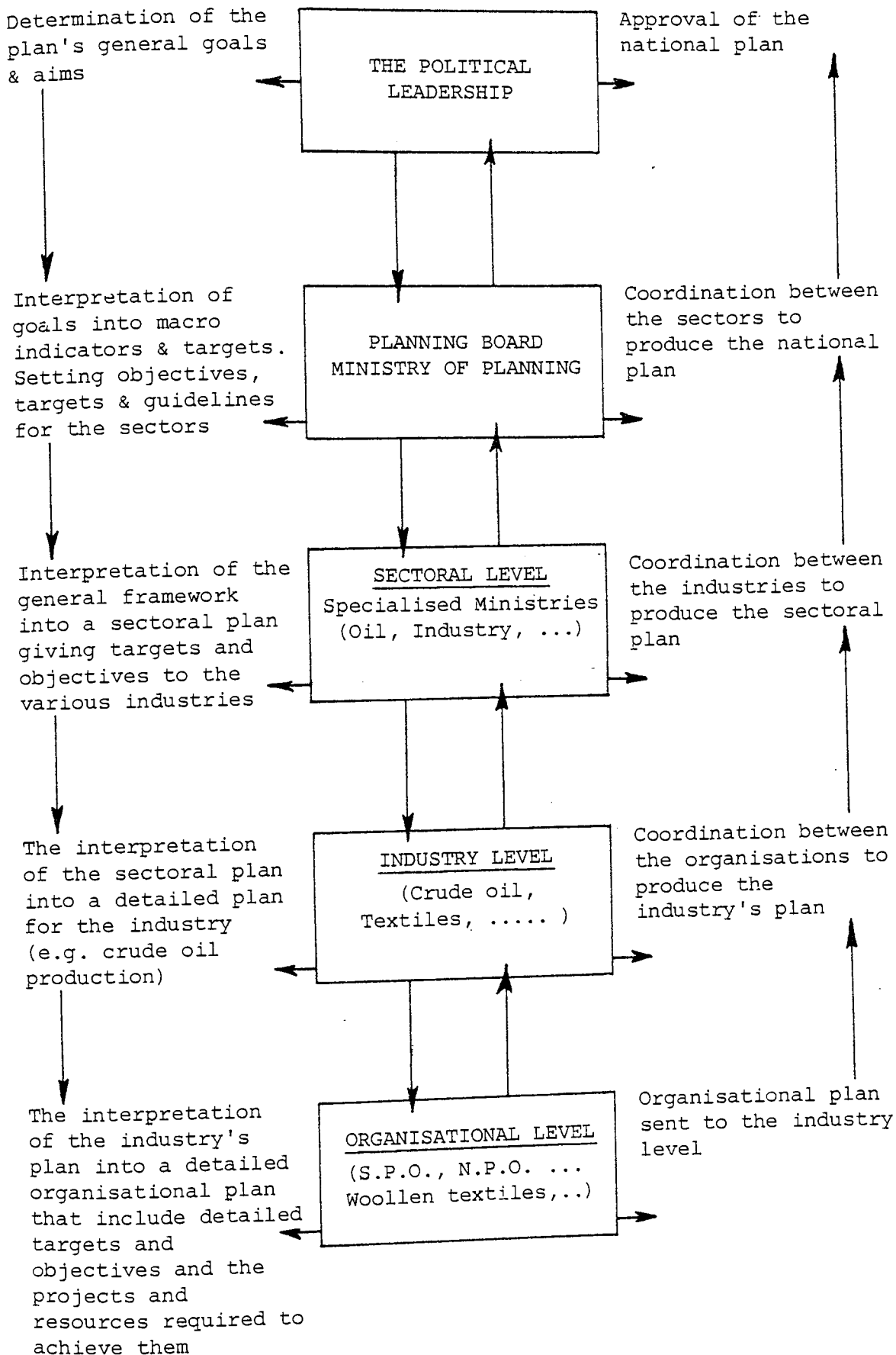


Fig 7.3: Formulation Process of the Iraqi National Plans

agencies and the implementing organisations to the achievement of the goals and targets of the development plans, the levels of implementation (as measured by the percentage ratio of the capital spent to the capital allocated) have been improving steadily over the years; from an average of 54 percent over the period 1951-1969 (Ali, 1982) to an average of 69.7 percent over the period 1970-1975 (see Table 7.4 for details of the implementation levels over this period). However, in spite of this marked improvement, the political leadership has continuously stressed that the implementation performances were below the desired levels (Ali, 1982), and has repeatedly urged all concerned, according to INOC 5, to:

"Determine the planned commitments according to our realistic implementation capacities."

The responsibilities of the central planning bodies are not restricted to the formulation and supervision of implementation of the national plans, but extend to the control and management of the vital resources that are required for their implementation. The fast pace of development witnessed since the early seventies have resulted in hugely increased demands on the principal resources of money, manpower and materials. However, since the rapid increase of oil revenues at the end of 1973, the emphasis has shifted from money (which was the principal constraint to development prior to 1973) to materials and manpower.

Severe shortages in building materials were experienced during the late seventies. This shortage caused the Ministry of Planning to demand details about the building materials requirement for every proposed project, and it made the approval and scheduling of any project a function of its material requirements, in addition to the usual consideration of needs, priorities and benefits. This enabled the Ministry of Planning to regulate demand for building materials by; the filtering and rescheduling of projects; advising organisations to use systems and technologies that involve minimum use of these materials; coordinating with the



Aston University

Content has been removed for copyright reasons

Sources: Ministry of Planning (1978a): The National Development Plan 1970-1974, Baghdad, Iraq.

Ali (1982).

Table 7.4: Implementation Levels of the Iraqi Development Plans over the Period 1970-1975

Ministry of Industry to expand its material production; and, advising the policy-making bodies to encourage loans and investments to promote the private building materials sector. However, the scarcity of manpower has represented a much bigger challenge and will be dealt with separately later. Since 1981, the resource of money has again become a prominent consideration in any investment decision, this is because of the financial drain that the war with Iran has imposed on the country.

The implementation of the plans and programmes, through the execution of development project, has to be carried within the prevailing framework of policies, guidelines and regulations; these may cover such issues as equipment purchasing, choice of contractors and consultants, training of personnel, recruitment of technicians and experts, ---- etc. Although Iraq adopts the principle of "Central planning and autonomous implementation", nevertheless, the prevailing approach to decision making is very close to the "rational comprehensive" approach, detailed in section 2.2.1, whereby ministries and organisations are required to operate with complete adherence to these policies and guidelines. This adherence is reinforced by continuous demands for discipline, loyalty and devotion to duty and to the wellbeing of the country. It is also understood by all that the non-adherence to the established policies and guidelines will not be tolerated and, if made, has to be fully justified. However, channels for the revision and modification of these policies are in existence with a high degree of openness and efficiency.

Having discussed the national planning and decision making environment, the focus in the next section will be narrowed to the discussion of planning and decision making within the Iraqi oil sector.

7.3.2 The Iraqi Oil Sector: Iraq is an oil-dominated economy. Oil revenues constitute the main source of development finance, account for the major source of foreign exchange, and contribute the largest share to gross domestic product (GDP). In 1968, oil accounted for almost a third of nominal GDP, whereas in 1975 it accounted for almost 60 percent; a jump caused by the dramatic increase in oil prices at the end of 1973. However, the reduction of this dependency on oil and the diversification of the economic structure have been the principal stated objectives and aims of the successive development plans and programs, and, as a result, the contribution of the oil sector to GDP has been reduced to 53.5 percent in 1976 and to 50.6 percent in 1980; this is in spite of very large increases in oil revenues over the period. These facts give an indication of the relative successes of the 1970-1974 and the 1976-1980 plans (Abed & Kubursi, 1980; Ministry of Planning, 1983).

The Iraqi oil sector is run by a functional ministry - the Iraqi Ministry of oil. The ministry is responsible for all the facets of the oil industrial process including refining and products distribution.

The crude oil industry - the exploration, production, transportation, storage and export of crude oil - is run by INOC via its constituent organisations SPO, the Northern Petroleum Organisation (hereafter NPO) and the central establishments within the INOC headquarters (see Fig 7.2). The case example and the field investigation falls within this crude oil industry which provides the immediate decision making environment for the LPG project. Hence, the analysis and the treatment will only cover the crude oil stream within the Ministry of oil.

To carry out the implementation of the huge and strategic projects within the oil sector - projects such as the "strategic line" linking the northern transportation system with the south; the "Albaker terminal", a deep sea loading terminal in the Gulf; and the "Turkish line" transporting Iraqi oil to the Mediterranean via Turkey - the State Company for the Construction of Oil

Projects (henceforth - SCCOP) was created in the middle sixties. From its humble beginning of implementing petrol stations and small projects, SCCOP has progressed in the middle and late seventies to the full management of the interface between the foreign contractors and the operating organisations during the design, construction and completion stages of major projects. Over this period, it has accumulated valuable experience and knowhow, that enabled it in the early eighties, to carry out the construction of medium size projects. Indeed SCCOP 2 stated that:

"The direct implementation of major projects has always been the principal objective according to which SCCOP was formed. Hence, apart from ensuring that the projects constructed by the foreign contractors are sound and efficient, the accumulation of experience and knowhow to enhance SCCOP's ability for direct implementation, constitute the major objective of our effort."

Planning in INOC follows closely the planning process shown in Fig 7.3, with each operating organisation preparing the draft of their five year plans according to central and sectoral guidelines, policies and targets. These drafts are then widely discussed within INOC and with other related organisations such as SCCOP. The board of INOC approves the modified draft and sends it to the planning ministry where requirements for resources are analysed and coordinated by the functional commissions and the principal indicators and targets are included in the national plan. The plan is then approved by the planning board and sent back to INOC for implementation. Since vital resources such as money and materials will be allocated to INOC according to the approved version, great emphasis is placed on the requirement that commitments in the plans are fully implementable and are seen to be implemented. It is according to the final, and approved, version of the organisations' plans that other support bodies within INOC, such as the General Directorate for Reservoir and Field Development which is responsible for the planning stages of major projects, and outside INOC, such as SCCOP, will draw their own detailed programmes for the planning and implementation of the projects included in the organisations' plans.

The above outline of the Iraqi oil sector will help in the identification of the roles and objectives of the principal actors in the decision making process. However, before tackling this within the context of the case example, it is necessary to examine the national and sectoral environment of the manpower criterion since the assessment of the feasibility of the integrative methodology will concentrate on its ability to integrate this criterion in technological decision making processes typified by the case example.

7.3.3 The Manpower Constraint:

A. Manpower at the National Level - Central Allocation and Strategies

The inadequacy of the manpower resource, both in quantity and quality, has been singled out as the main impediment to rapid development in Iraq. The central report of the Ba'ath party (A.B.S.P., 1982) related the underachievement of the national plan's 1976-1980 targets and objectives in the industrial sector, directly to the inherent weaknesses of the national manpower resource, and enumerated the factors that caused these weaknesses, as follows:

- (1) The low technical standard of the employees in the industrial sector and their ignorance of modern technological development; the manpower industrial base is still below the required standard qualitatively and quantitatively and needs great efforts to develop it and to raise its ability.
- (2) The continuous imbalance between the middle technical cadres and the engineers cadres both qualitatively and quantitatively. This causes the submergence of the engineers in routine technical duties and the neglect of the development and creative aspects of the production process.
- (3) Inadequate absorption of modern technological processes and

techniques which results in increased problems and stoppages of modern machines and equipments.

- (4) The large and rapid growth of the industrial base without a parallel increase in the provision of adequate and technically capable manpower. This caused the overloading of existing manpower with duties above its capacities; resulting in reduced productivity, and the delegation of leading industrial duties to people that have low capability and experience.
- (5) In spite of the desperate needs for manpower in latest years, the phenomena of latent unemployment is still rife in some of the organisations of the industrial sectors. This is especially so in the long established organisations and especially in their administrative functions.

To coordinate the task of realistic and thorough consideration of the manpower resource in the preparation and execution of the development plans, a commission - The Manpower Planning Commission - was formed in the Ministry of Planning. This commission was intended to act as an interface between the manpower demand centres i.e. the implementing ministries and agencies, and the manpower supply centres i.e. the Ministries of Education and Higher Education. The commission has carried out directly, and has commissioned, many studies to identify discrepancies between supply and demands of various skills and bottlenecks in the labour markets, and formulated proposals and advice which were presented to the policy making bodies to overcome, or reduce, these discrepancies and bottlenecks. It has also carried out the manpower balance of the national development plans; the demand for labour determined according to the advice of the implementing ministries and agencies, and the supply of labour according to the present and envisaged capacities of the educational and training establishments. A detailed higher-education graduates balance, which was

prepared for the 1976-1980 plan is shown in Table 7.5. Although the figures given in the table reflect very serious shortfall of higher education graduates over the plan's years, however, the actual situation was not as bad as it looked. MP1 justified this as:

"Ministries and demand centres usually exaggerate their requirements and educational supply sources tend to underestimate their turnover. However, it has been recognised at all levels that the shortage of skilled and educated manpower is very serious indeed."

Due to the size of the skills shortfall between supply and demand and to ensure that these shortfalls are distributed and controlled properly, the commission was entrusted, via the revolutionary command council directive No. 1002 of 30.7.1978, with the task of allocating the university and technical institutes graduates, in the vital specializations, to the various ministries and demand centres. This allocation process has progressively gained in sophistication since then (Abed & Kubursi, 1980). The principles upon which the allocation process is based were outlined by MP1 and MP2 as follows:

- (a) Prior to graduation, each student is required to fill a form which, in addition to details of his impending qualification, should specify six ministries and six locations (chosen from the country's 18 governorates) within which he wants to be employed and in order of preference. This is administered by the educational establishments themselves.
- (b) Each ministry fills a form detailing its requirements for the coming year for the various critical specializations distributed against each of the 18 governorates.
- (c) The commission matches the supply of higher education graduates to the demand for them according to the following:
 - Prior to allocation, the commission has to follow certain established policies and regulations and to implement certain directives (mainly from the Revolutionary Command Council and the Presidential

Content has been removed for copyright reasons

Source: Ministry of Planning (1974): The Final Report of the Committee to Study the Requirements of the National Development Plan for Various Specialisation for the Years 1975-1980 (Arabic)
Ministry of Planning, Baghdad, Iraq.

Table 7.5: Estimated Balance between Supply of Higher Education Graduates and Manpower Needs for the National Development Plan 1975-1980

Office) e.g. sons and daughters of the war martyrs have the the right to choose their employing ministry and the governorate of work; the universities and colleges have the option of appointing the top 10% of their graduates as part of their academic staff.

- It tries to allocate, as much as possible and with the aid of a large data base and sophisticated computing software and hardware facilities, each graduate to his preferred ministry and governorate.
- If, for a certain specialization, the supply exceeds the demand, the demand will be met in full and the surplus distributed among the ministries either, in proportion to their original requirements, or, by allocating the surplus, in a specialization, to its "primary" employer e.g. surplus petroleum engineers are allocated to the oil ministry which is regarded as the "primary" destination for such engineers.
- If, for a certain specialization, the demand exceeds the supply, a situation normally encountered in most technological and scientific skill categories, then the number allocated to each ministry will be in proportion to the ratio of the ministry's demand to the total demand in that specialization.

- (d) The commission then advises the employing ministries and organisations of the possible options that they can adopt to close the gap between what they demanded and what they were allocated. This is achieved by informing them of the agreements that have been established between Iraq and other countries in the fields of training and labour migration; by advising them about the preferred sources, foreign and Arab, of skills and the established policies towards, and experience with, importing skills from each of these sources; and by helping the ministries in the process of obtaining rare skills by its ability to initiate government-to-government agreements.
- (e) The commission analyses all the discrepancies between supply and demand

for each category, and closely observes the trends and directions these discrepancies are following. It transforms these analyses into indicators for the manpower supply establishments to consider in their future plans; into policy suggestions for the policy making bodies to adopt; and into guidelines to the employing ministries to follow when preparing their future plans and programs.

The allocation of graduates to ministries is compulsory, and although that seems conscriptive, it has the advantages of secure and automatic employment to the graduates, and provides the requisite control of the vital skills that are essential for the development process. The moral justification of this system was elaborated by MPI thus:

"To achieve rapid and balanced development is a goal which is as noble and important as the defence of the country. So, if we adopt conscription for national service, I see no reason why we cannot allocate, at least initially, a graduate to a certain vital job in a certain vital location, with all the associated provisions of choice of employers and locations catered for and with all the job security that entails."

To tackle the problem of scarcity of skilled and educated manpower, which was dislocating the country's development plans (Cockburn, 1978), the Iraqi government adopted diversified and far-reaching strategies. The most important of these strategies were:

- (1) The expansion and development of the education system with emphasis on vocational and higher technical education. Table 7.6 shows the growth in the number of vocational schools, students and teaching staff over the period 1972-1982. Table 7.7 shows the growth in the number of students in the universities and technical institutes over the same period. This is in addition to the training centres run by the functional ministries for the training of their own workforce; in 1978, the number of such centres was 30 distributed among 7



Aston University

Content has been removed for copyright reasons

- Sources: - Ministry of Planning - Annual Abstracts of Statistics 1980, Baghdad, Iraq.
- Ministry of Planning - Statistical Pocket Book 1982, Baghdad, Iraq.

Table 7.6: The Growth of the Iraqi Vocational Education Over the Period 1972-1982



Content has been removed for copyright reasons

- Sources:
- Ministry of Planning - Annual Abstract of Statistics 1980, Baghdad, Iraq.
 - Ministry of Planning - Statistical Pocket Book 1982, Baghdad, Iraq.

Table 7.7: The Growth of the Iraqi Higher Education over the Period 1972-1982

ministries and with combined capacity to train 13000 trainees per year (Ministry of Planning, 1978a; Sabie, 1980).

- (2) The improvement of the participation rates of the population in general and for women in particular. This strategy had to contend with great obstacles concerning social, cultural and religious values, attitudes and perceptions. Major campaigns and efforts were undertaken to eradicate illiteracy and to educate the masses. These were coupled with measures and incentives that encourage participation and self improvement. Although, no detailed longitudinal data are available, nevertheless the results of these campaigns have been encouraging so far (A.B.S.P., 1982). Accurate figures taken from the national census of 1977 (conducted at the peak of the development drive) are shown in Tables 7.8 and 7.9. These tables provide an accurate snapshot of the participation of the working-age population according to their sex, age group and educational levels. The tables reveal that women contributed approximately 18 percent of the total workforce; a very encouraging figure considering the traditional characteristics of the Iraqi society and its underdeveloped state (A.B.S.P., 1982). There are other encouraging signs of Iraqi women development and participation, such as, in 1980, they constituted 46 percent of students in primary education and 37.2 percent of students in higher education (A.B.S.P., 1982).
- (3) The enacting of policies and laws that are designed to reduce the effect of the manpower shortages on the development process. The most important of the policies was the open-door policy, adopted in 1977, to attract skilled labour from other Arab countries. According to this policy, any Arab national could come and seek work in Iraq



Aston University

Content has been removed for copyright reasons

WORK.

Source: Figures computed from Ministry of Planning (1978b):
Census 1977, Baghdad, Iraq.

Table 7.8: The Distribution of the Iraqi Human Force according to
Sex, Education Level and Economic Participation

Content has been removed for copyright reasons



Aston University

Content has been removed for copyright reasons

Source: Figures computed from Ministry of Planning (1978b):
Census 1977, Baghdad, Iraq.

Table 7.9: The Distribution of the Iraqi Human Force according to
Sex, Age Group and Economic Participation

without license and work permits, and paid with generous allowances for housing and costs of living and generous foreign exchange regulation. This policy resulted in vast immigration of Arab labour (especially from Egypt) and, according to the Iraqi first deputy prime minister, the number of foreign workers (with Arabs constituting the vast majority) working in Iraq in 1983 exceeded 1.5 million (Alf Baa', 1983). Also, to ensure the speedy implementation of large strategic projects, Law 157 of 1973 was enacted (Ali, 1982). This law stipulated that any project, covered by this law, can be implemented, wholly or partially, by imported labour, materials and equipment and, if necessary, bypassing existing policies and regulations covering imports control, customs, taxes, etc. The utilization of this law has enabled the implementation of vast and strategic projects in record time, especially in the oil sector (Oil & Development, 1977). However, no project can be covered by this law, unless it is specifically approved by the Presidential Office or the Ministers' Council (Ali, 1982) and their approval is usually restricted to the major, strategic and complex projects.

B. Manpower in the Oil Sector

In any analysis of the manpower constraint, it must be remembered that the oil sector is basically a capital intensive industry. Hence, although it contributes more than 50 percent of the country's GDP, it only employs a small proportion of its economically active population. In the general census of 1977 (Ministry of Planning, 1978b), it was found that the Mining sector (in which the crude oil industry constitute by far the major component), employed a total of 36835 out of economically active population of 3,059,214 i.e. a proportion of 1.2 percent, compared with 9.3 percent in the Manufacturing sector and 30.8 percent

in Agriculture. The technological level of the Mining sector is also reflected in the proportion of high level personnel it employs to its total labour force; the 1977 census found that the number of what it termed as occupation 1 (professionals and technical specialists), employed in the Mining sector was 3420 i.e. 9.3 percent of the total, compared with 2.5 percent in Manufacturing and 0.5 percent in Agriculture. This technological level and the long history of the Iraqi crude oil industry and its long association with multinational corporations, prior to its nationalization, have combined to turn it into the country's main reservoir for the training and grooming of engineers, scientists and managers for other sectors, and the vehicle through which a large proportion of advanced technological equipments and systems, imported from the developed nations, are transferred, assimilated and adapted. Indeed, its stock of skills, quantitatively and qualitatively, has enabled it to achieve the distinction of being the first crude oil industry in the developing world that is operated fully by national personnel (Odell, 1981).

The General Establishment for Oil Training (G.E.O.T.) was formed in 1979 to coordinate the training and development of personnel within the sector; act as an interface between the Manpower Planning Commission in the Ministry of Planning and the Oil Ministry and its constituent organisations; coordinate the oil sector manpower requirements; and, distribute the sector's allocated manpower among its constituent organisations.

G.E.O.T. was also entrusted with the responsibility of running the Oil Training Centre; a specialised centre belonging to the Ministry of Oil and has two branches - one in Baghdad and the other in Kirkuk in northern Iraq. The Baghdad centre was formed in 1970 and started actual training in 1972, the Kirkuk centre was inherited from the foreign oil company and was amalgamated with the Baghdad centre in 1972. The centre recruits trainees from students who have

completed the general secondary level (equivalent to the British sixth form i.e. 18 years old) and give them two years training in 18 technical categories relevant to the oil sector in the production and refining processes. The centre has expanded rapidly in both student numbers and technical categories; the number of trainees in 1982 was 4146 with the number of entrants for the same year being 2290.

The allocation of graduates of the oil training centre, among the various organisations within the oil ministry, is directly controlled by G.E.O.T. and they are exempted from allocation by the central Manpower Planning Commission. The G.E.O.T. allocation is done according to the same bases followed by the central commission, with the added provision that the allocation may be modified at short notice by the higher echelons of the oil ministry; it is not an unfamiliar occurrence when the whole yearly graduates in certain categories are allocated in bulk to a particular organisation to man a certain project or enterprise.

The contribution of the Oil Training Centre, to solving the sector's problems in the critical middle-level skills, is immense. To reflect this contribution, Table 7.10 shows the number of graduates, according to specialisation, that were allocated to the various organisations within the sector over the period 1979-1982, and Table 7.11 shows the total number of centre's graduates that were working in these organisations in 1983.

On the organisational level, the operating crude oil organisations (such as SPO) specify their manpower requirements in bulk when they prepare their five year plans, and yearly submit to G.E.O.T. their specific requirements for high level manpower categorised according to specialities and the governorates that they are required to work in. The gross figures in the five year plans are sums which are based on "guesstimates" by the functional departments and usually reflect percentage increases in gross indicators such as the anticipated increases in oil production over the planned period and the anticipated capital investments

Content has been removed for copyright reasons



Aston University

Content has been removed for copyright reasons

Source: G.E.O.T., Baghdad, Iraq.

Table 7.10: The Distribution of the Graduates of the Oil Training Centre over the Three Years Period 1979-1982



Aston University

Content has been removed for copyright reasons

Source: The Management of G.E.O.T., Baghdad, Iraq.

Table 7.11: The Number of Oil Centre Graduates who were working
in the Oil Organisations in 1983

(manpower development planning, in the sense of detailed projections forward of current manpower, is still in its infancy and rarely practised). Table 7.12 reflects the relationship between the percentage increases in oil production, the planned financial capital investments and the increases required in the labour force as stipulated by the SPO's five year revised plan for the period 1979-1983.

However, requirements supplied yearly by the SPO are rarely met in full, especially in specializations that are in high demand by other sectors e.g. Electronics Engineers and Technicians. Hence, it has to depend on other options to satisfy its requirements. The main option used is to employ non-Iraqi (Arab & foreign) personnel at the professional, skilled and semi-skilled levels (since, the shortage is not only confined to the high level manpower, but it includes various vital skills such as Welders, Mechanics, Electricians, etc). However, the experience of the crude oil organisations is not a happy one, and these organisations are very reluctant to employ large number of non-Iraqi skills, mainly due to the following reasons:

- (1) Non-Iraqi labour employment is usually short term, they are usually intent on staying and working a relatively short period in Iraq with the maximisation of earnings as their main motive. This causes them not to perform to a standard expected from career oriented labour. Hence, they are more suitable to construction and installations work than to operations and development.
- (2) The wages and privileges enjoyed by non-Iraqi labour are much higher than for the national force; this is to enhance the attractiveness of working in Iraq. This causes negative effects on the morale and the motivation of the national labour.
- (3) The cultural and social problems associated with the assimilation of labour from diversified ethnic origins; this causes great difficulties in communication and social interaction.



Aston University

Content has been removed for copyright reasons

Source: Technical managers within the SPO, Basrah, Iraq.

Table 7.12: Relationships between Increases in Gross Indicators and Increases in the Required Labour Force, as Envisaged by the SPO Five Year Plan 1979-1983

- (4) The general unwillingness of the non-Iraqi labour to transfer their ability to national labour. This is mainly because they want to protect their employment while they are in the country.
- (5) Some industries, especially the crude oil, attach great importance to issues of security, loyalty and discipline, this is because of the importance of the sector, the nature of its technology and processes and the volatile political environment in the region as a whole. This works directly against the employment of non-Iraqis; with their diversified origins, suspect loyalties and undefined political affiliations and tendencies.

All the above aspects, whether on the national, sectoral or organisational levels, combine to make the manpower constraint the most prominent of the bottlenecks that hinder the development programme in Iraq (Abed & Kubursi, 1980). Indeed, for the implementation of the SPO's five year plan 1979-1983, this problem was stated by SPO 2, thus:

"The 1979-1983 five year plan was distinguished by the fact that the biggest hurdle the organisation had to face was the provision of the technical and administrative cadre necessary for the organisation to fulfill its commitment."

Having outlined the national and sectoral planning environment and procedures and having analysed the manpower constraint at the national, sectoral and organisational levels, the next section will outline the immediate environment and decision making system that characterises the LPG project.

7.4 THE LPG PROJECT

7.4.1 Background and General: The utilization of natural gas, that

accompanies the production of crude oil, has been one of the main goals of successive Iraqi governments. Over the years, the associated gas was flared in huge quantities by the foreign oil companies (apart from minute quantities utilized for their local energy needs) hence, this important asset was used to light the desert instead of supplying the country's energy needs and earning hard currency by its export. This issue contributed to the deterioration of relations between the Iraqi government and the oil companies; it figured prominently in the 1960 negotiation which led to Law 80 of 1961 which limited the companies to its already exploited fields; and in the 1972 negotiation, the failure of which led directly to the vital step of nationalisation of the companies' northern operations.

The eighth congress of the ruling Ba'th party held in 1974, specified three basic tasks that had to be accomplished by the oil sector over the following five years; the first, was the speedy completion of the strategic oil projects that will ensure flexibility and security for the transportation and export of crude oil; the second was the establishment of the biggest possible petro-chemical industry, and the specific expansion of the refining industry, and it dismissed a policy which is confined to exporting crude oil as:

"A policy for underdevelopment, incompatible with our pan-Arab aspirations and unable to give us a role in world oil affairs.";

the third task was to carry out an accurate survey of the country's oil reserves (A.B.S.P., 1974).

In response to the above central directives, the Oil Ministry, in 1975 produced detailed objectives, policies and guidelines concerning the utilization of the associated gas; these were outlined briefly by PSF 1 thus:

"It was decided, that immediately after the completion of the strategic transportation and loading projects, the utilization of the associated gas, which was being flared in the oil-producing fields, should be embarked upon. A policy was formulated dictating that no future oil field should be developed without the prior provision for the full utilization of the associated gas built into its development plan."

PSF 2 justified the huge investments and efforts in such a task, as follows:

"The utilization of the associated gas is vital because it will provide new alternative energy for the country; it will ensure that an important national asset is not wasted; it will bring huge revenues to the country; and, it will serve as a base for petro-chemical technology transfer and the creation of trained and efficient technical cadres."

In 1977, the first stage of the southern LPG project was completed at a cost of 90 million dollars. This stage was an interim project designed to meet the immediate energy demands of the Southern industrial complex and the local power generating plants.

In 1978, the second, and main, stage of the southern LPG project was initiated and was scheduled to be implemented over the period 1978-1983, with a total estimated cost of 1.35 billion dollars. The project basically involved: the gathering of the associated gas from the North and South Rumaila fields in southern Iraq at an average of 10 million cubic metres per year; the extraction of the natural liquified gas (NGL) with a yearly capacity of 2 million tons of Propane, 1.38 million tons of Butane and 1.22 million tons of natural Benzine; the export of these products via a purposely built loading terminal capable of receiving 20-50x10³ tons tankers after the dredging of a suitable water canal for this purpose; and, the supply of LPG (Methane and Ethane) for domestic and industrial consumption to complement the already completed first stage. Fig 7.4 shows the basic layout of this project.

The LPG project was approved to be implemented according to Law 157 of 1973 (Ali, 1982), with its associated authorities and flexibilities and was classified as one of the vital, and strategically important, development project.

7.4.2 Implementation - Roles and Responsibilities

The LPG project was included in the SPO five year plan of 1976-1980 and its revised five year plan of 1979-1983. Financial allocations to implement the project were included in the investments provisions for the oil sector in the five

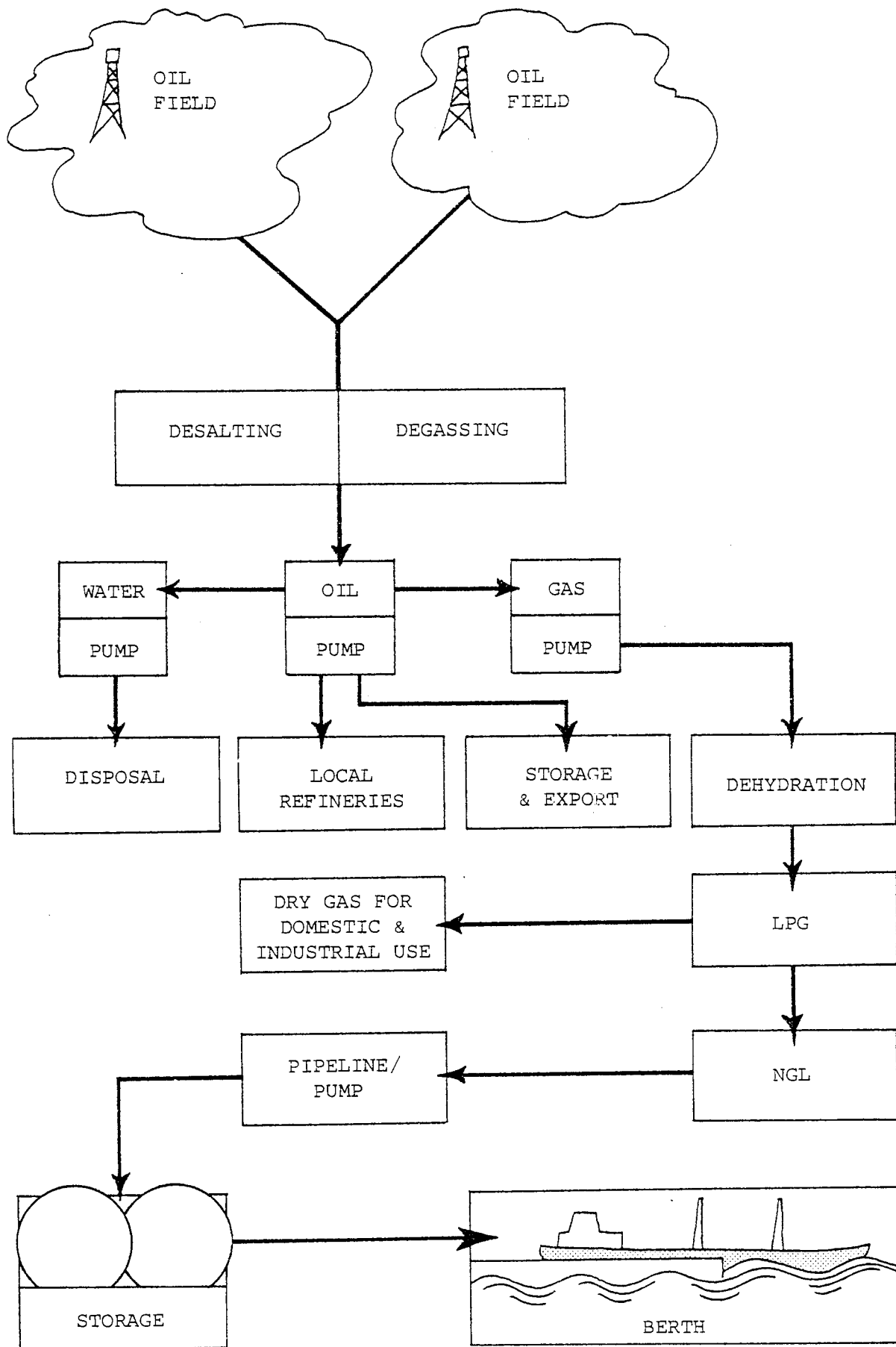


Fig 7.4: Basic Outline of the Southern LPG Project

year national plan 1976-1980 and in the yearly investments programs that were based on it. The Ministry of Oil delegated the responsibility of its planning, implementation and operation to I.N.O.C. and its constituent organisation the SPO; this represented a new challenge to these organisations since they did not have much expertise in complex petro-chemical processes, but, it was thought advantageous to delegate the LPG responsibility to INOC, instead of the Refinery Organisation, because of: the physical proximity of the LPG to existing oil installations; the perceived higher ability of the crude oil industry to adapt to new technologies and processes; and the experience gained by the crude industry during the implementation of the first stage (which was completed in 1977), although on a much smaller , and simpler, scale.

Accordingly a project team was set up in INOC headquarters in Baghdad, in 1978, in the General Directorate of Fields Development. The team consisted of a project coordinator and engineers and specialists delegated to him from other functional departments within the directorate. This team was to be responsible for the basic formulation of the project, the coordination of the predesign studies and generally responsible for acting on behalf of INOC and SPO during the implementation stages of the project. During the initial stages, the team had to hire the services of various foreign consultants and experts to enable it to carry out its studies and basic formulations; such as the detailed chemical analysis of the associated gas produced in the southern oil fields.

The project coordinator reported directly to a high level committee which supervised the implementation of the major and vital oil projects; the committee was chaired by the Minister of Oil and included in its memberships the Director Generals of establishments that deal with fields developments and the Presidents of the oil operating and project construction organisations. This committee had the authority of the central planning board invested in it and its decisions were irreversible even by the INOC board, and it was basically formed to ensure the

speedy and efficient implementation of major projects.

SCCOP was delegated the task of implementing the LPG project. A project manager was appointed, and engineers and experts from the functional departments within SCCOP, were delegated to him. The project manager had the basic task of acting as an interface between the Planners and Operators (INOC and SPO) and the foreign contractors and consultants. Due to the complexity of the LPG process and the novelty of its technology SCCOP was requested by INOC to accept only a skeleton formulation of the project from them, and that SCCOP should then carry out the preparation of the conceptual designs (this was a one-off request since INOC usually submits to SCCOP detailed conceptual design documents in cases involving crude oil fields development).

To execute these responsibilities properly, SCCOP hired an internationally renowned firm of consultants and contractors to carry out the following tasks:

- To produce the relevant documents - by dividing the project into packages - according to which international contractors will base their bids.
- To help SCCOP in the evaluation of these bidding documents and the selection of preferred contractors.
- To provide SCCOP with the necessary expertise to supervise the construction, testing and commissioning of equipments, processes and systems.

At the very early stages of the formulation of the project, the project's eventual operator, the SPO, appointed an LPG coordinator to act as an interface between the project teams in INOC and SCCOP on one side and the functional and technical departments within SPO, on the other.

From the above brief description of the roles of the various organisational units involved in the planning and implementation of the LPG project and

referring back to the classification of actors given in the general technology choice situation (chapter 3), it is clear that the following mapping is applicable in the context of the LPG project.

- Arbiters (A) : The higher committee for the implementation of oil projects
- Planners (P) : INOC Baghdad, specifically the LPG project team in the Baghdad headquarters
- Implementors (I) : SCCOP, specifically the LPG project management
- Operators (O) : SPO, specifically the LPG project team in Basrah and the functional departments.

The schematic relationships between these actors are depicted in Fig 7.5, and their responsibility matrix is shown in Fig 7.6.

7.4.3 Actors - Concerns and Objectives: Actors, in any decision making process, have differing attitudes, interests, concerns, values and objectives. This results in them having differing, mostly contradicting, stances towards alternatives and the criteria that they are evaluated against.

In the LPG project, the Arbiters i.e. the higher committee, demanded that all the other actors must decide within the established policies, guidelines and standards, and that none of these should be contravened unless authorization were obtained from the relevant authorities. However, in situations which are not covered by existing policies and regulations, the Arbiters encouraged all concerned to indulge in complex interactions and dialogues to achieve consensus which should be in unison with the established ethos. If a decision still cannot be agreed upon and basic conceptual issues are involved, then, the committee will take its decision after a briefing by the Planners i.e. INOC. This seems fine on paper, but the author has found basic irreconcilable and deep seated

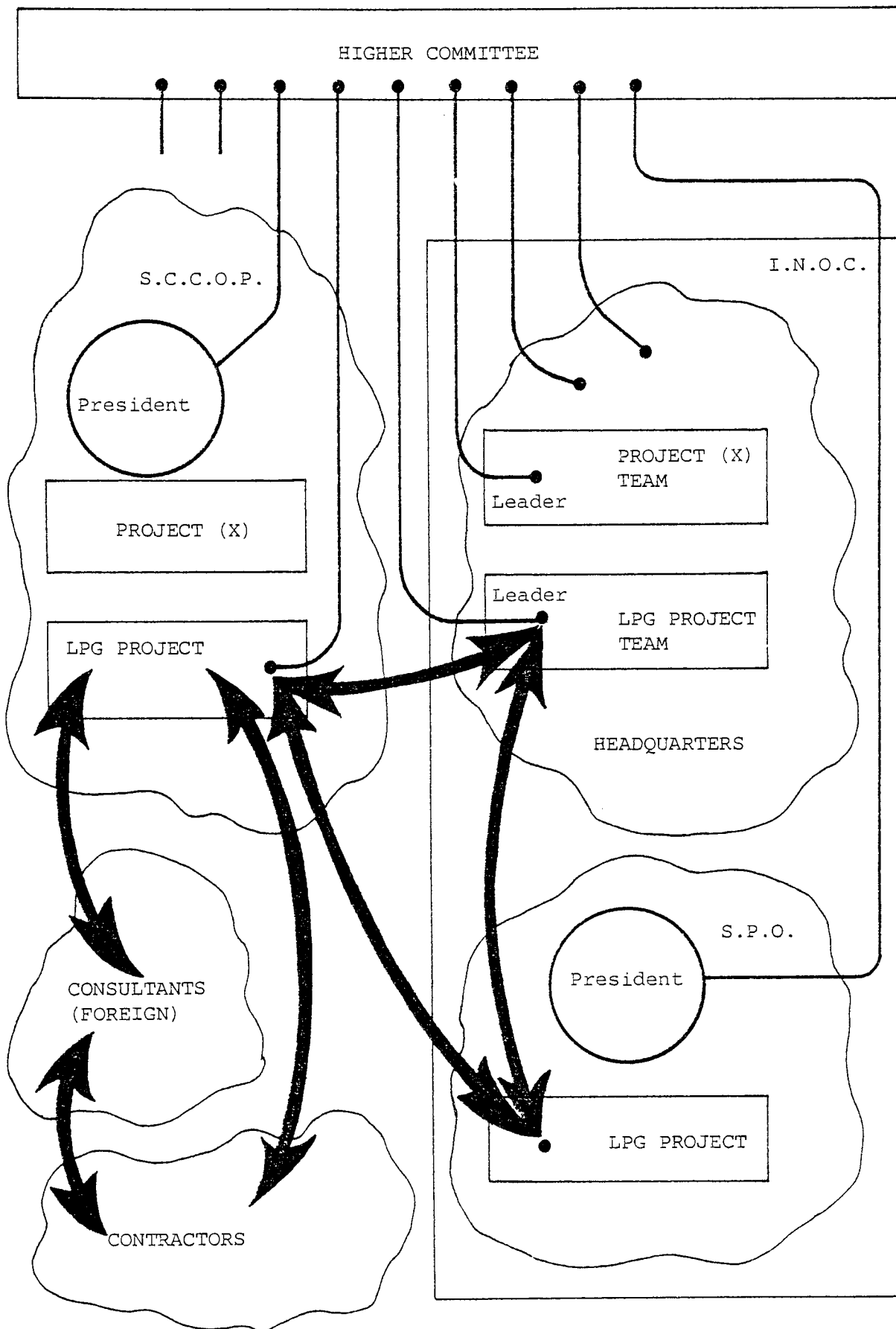


Fig 7.5: Schematic Relationships Between the Organisational Units Involved in the LPG Project

LEGEND : V.L - Very Low
 L - Low
 M - Medium
 H - High
 V.H - Very High

| ACTORS STAGES | HIGHER COMMITTEE (A) * | INOC (P) ** | SCCOP (I) *** | SPO (O) **** |
|-------------------|------------------------------|-------------------|---------------------|--------------------|
| FORMULATION | H | V.H | V.L | V.L |
| CONCEPTUAL DESIGN | M | M | M | V.L |
| DETAILED DESIGN | V.L | M | V.H | V.L |
| CONSTRUCTION | V.L | L | V.H | M |
| COMPLETION | V.L | V.L | V.H | V.H |

Notes: * "Influence" constitutes the biggest component of the responsibility.

** "Accountability" constitutes the biggest component of the responsibility.

*** "Involvement" and "Accountability" are the main components.

**** "Involvement" constitutes the principal component.

Fig 7.6: Responsibility Matrix for the Principal Actors in the Implementation of the LPG Project

disagreements between the actors involved, with the Operators in SPO complaining bitterly about the scant attention and the unfair hearing given to their concerns and to the issues that are important to them. They were bitter because they felt, according to SPO 4, that:

"INOC and SCCOP should have strived to serve us and not tried to impose decisions on us, since, after all, we were the eventual operators in whose laps the project will be placed when completed."

However, before trying to assess the role the integrative methodology could play in such decision situations, it is necessary to summarise the general objectives and the domain of concerns of the principal actors in the LPG project.

The Arbiters' (i.e. the higher committee) concerns and objectives were summarised by INOC 4 as:

"Before the war, the committee's main concern was that the project should be completed on time and that the equipments and systems should be safe and reliable. Money was not a real obstacle because very generous allocations were made and upwards revision of these, if required, was very easy. The committee demanded and expected that decisions during the planning and implementation of projects should be arrived at after a wide and thorough discussion and dialogues with all the parties affected, especially the Operators. The committee also expected that important guidelines, such as diversity of suppliers should be enforced as strictly as possible. Of course, after the war started in 1980, the emphasis shifted to cost minimization and to flexibility, security and protection of plants and equipments."

The concerns and objectives of the Planners in INOC were summarised by INOC 1 as follows:

"Our main objective was to make sure that a technically and operationally sound project is completed in its scheduled time within the approved budget and without contravening the established policies, guidelines and standards. At every major step of the project, such as the completion of the draft of the pre-design decisions report, we have tried to involve the Operators and the Implementors in the discussions and we tried to include their suggestions and recommendations, and if that was not possible, then tried to explain why. But, sometimes the demands of the Operators are so infeasible that it reflected their overriding concern for future easier operations and the neglect of everything else."

The concerns and objectives of the Implementors at SCCOP, were summed up by SCCOP 2 as follows:

"We are expected to act in exactly the same way a private contractor would act. Because of this our objectives are usually confined to the completion of projects on time, within the approved budget and ensuring that we construct a reliable and technically sound project. But, added to that, we are also expected to improve the ability of SCCOP and strive towards the ultimate goal of being able to implement major oil projects directly and wholly. Due to this, there is a clear tendency among our ranks to seek the most advanced technologies and systems and to diversify the sources of advice and consultancy."

However, the concerns and objectives of the Operators at SPO totally differed from those of the Implementors and the Planners; SPO 1 and SPO 3 summed them up as follows:

"We are the ones in whose laps these projects will eventually fall, and have to operate, maintain and develop them. Yet, it is very difficult to obtain, train and prepare the personnel that are required for these tasks. Hence, our main concerns during the planning and implementation period were to make sure that labour and skills saving technologies and systems were adopted. This is usually reflected in our insistence on the standardisation of equipment; in our preference of labour saving technologies; in our demand for generous standby systems and spare units; and, in our emphasis on flexibility in design and reliability of systems and equipments. However, our efforts are not successful sometimes; Planners and Implementors usually invoke the criteria of cost and completion time to refuse our demands and they have, especially the Planners, the proximity and access to the supreme decision makers to ensure that their point of view prevails. We must add however that the occasions where we had irreconcilable differences are usually few. Our participation in the decision making process leaves a lot to be desired; we are usually sent huge documents and told that a meeting to discuss our comments on them is to be held in a fortnight, this period is not enough to read them, never mind studying them critically; also, when our representatives are included in discussions with consultants, they are so underbriefed that they are unable to participate fully on our behalf, actually sometimes we feel that they include us in these discussions to authenticate their decisions and to give the impression that decisions are based on the widest possible discussions."

But, how can these diversified and contradictory concerns and objectives be reconciled effectively? And, how can the proposed integrative methodology help in such a decision environment?

The answers to the above questions will be attempted by assessing the application of the integrative methodology to a specific technological choice situation within the LPG project, namely, the prime-movers selection. This is the subject of the next chapter.

CHAPTER 8

CASE EXAMPLE : THE SOUTHERN LPG PROJECT

II. TECHNOLOGICAL DECISION MAKING

8.1 INTRODUCTION

This chapter is devoted to the assessment of the feasibility, and usefulness, of the proposed integrative methodology as related to an actual technological-choice situation within the LPG project context (as outlined in the previous chapter). The assessment also aims to outline the facilitating factors and processes that are required for the application of the methodology within the specific context of the case example. This outline should contribute to the formulation of an implementation strategy for the methodology, in the general situation of technological development.

A specific technology choice situation, namely - the prime movers case, is chosen as the actual case to carry out this assessment.

The assessment will be based on the following basic steps:

- (1) To outline the approaches, principles and methods that were adopted in the actual case.
- (2) To identify the weaknesses and shortcomings of the adopted approaches based on the roles, opinions and comments of the principal actors and on the analysis of results and information.
- (3) To map the principles and processes suggested in the integrative methodology to the case situation, and assess its possible contribution towards the avoidance of the above weaknesses and shortcomings.

The above steps will be applied to each of the principal phases of the decision making process - options generation, evaluation and selection - consecutively; this is to ensure proper mapping with the integrative methodology and closer scrutiny of the assessment.

8.2 THE PRIME MOVERS SELECTION CASE - BACKGROUND AND GENERAL

One of the major issues that confronted the Implementors at SCCOP during the "Conceptual design" stage, in early 1978, was the choice of prime movers that

are necessary for the transportation of the gas throughout the LPG project network. This issue was vital because of the following factors:

- (1) Prime movers are major critical items, they are manufactured on a one-off basis and have long delivery periods. Hence, they had to be ordered early to avoid them becoming a bottleneck in the implementation cycle of the project. Therefore, orders had to be placed without awaiting detailed designs or contractors' bids.
- (2) The selection of prime movers raised major policy issues, such as; diversified versus centralised electrical power generation; energy profile of the industry; multiplicity of suppliers. All these issues had not been settled before, and the LPG project presented the first opportunity to the recently nationalised oil sector to clarify these issues and analyse their impacts (previous major oil projects such as the "strategic line" were implemented on turn-key basis - because of their overriding strategic consideration - and this prevented the tackling of these issues then).
- (3) The prime movers involve substantial initial investments and running costs, hence a proper evaluation of their choice was considered essential.

In May 1978, SCCOP formally asked the foreign consultants to study the prime movers choice problem and present their recommendations. The consultants produced their report in July 1978.

In this assessment, the contents of the consultants' study, as well as the decision making process prior, during and after its formulation, will form the basis according to which the actual decision making process will be evaluated, at each of its constituent phases, and to indicate the contribution and improvement the proposed integrative methodology would have made at each phase.

However, to simplify the assessment and to avoid unnecessary details that

could cloud its main purpose, the assessment will be restricted to the choice of prime movers which drive the main compressors in the stage of gas compression only i.e. compressing the associated gas at the four production stations for the purpose of transporting it from these stations to the processing facilities (LPG and NGL - see Fig 7.4).

The assessment of the phases of the decision making process will be dealt with consecutively.

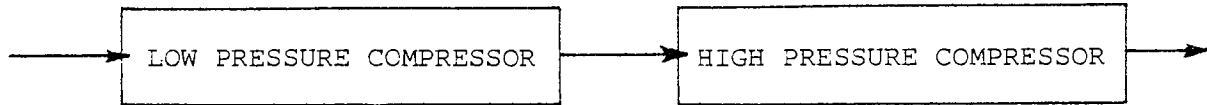
8.3 OPTIONS GENERATION

In a series of meetings involving SCCOP and the consultants, the following bases for the study were decided:

- (1) Only options involving Gas turbines and Electric motors should be considered.
- (2) Two equipment configurations should be considered for the compressors:
 - The low pressure (LP) and high pressure (HP) compressors driven by one common prime mover.
 - OR - By two separate prime movers.
- (3) Two plant layout systems should be considered (see Fig 8.1):
 - Single Compression train per compressing station (layout A).
 - Twin Compression train per station (layout B).
- (4) The Gas turbines options should be considered:
 - with energy saving regenerative cycle
 - without any energy saving systems.

Fig 8.2 represents the above variables and conditions in the format adopted in the proposed methodology (Chapter 5), complete with options bars that exclude incompatible states of the relevant variable. From this figure, it is clear that the feasible options, according to the bases of the study, should be 10 in number; as follows:

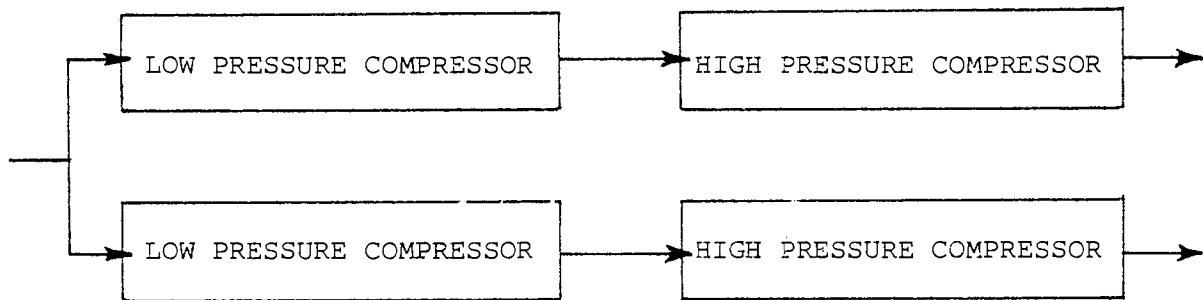
LAYOUT "A"



Single Compression Train per Station

- Equipment Configuration: Gas turbines - One turbine to drive both compressors (S)
OR - Two turbines to drive the two compressors (D)
Electric Motors - Two electric motors to drive the two compressors (D)

LAYOUT "B"



Double Compression Trains per Station

- Equipment Configuration: Gas Turbines - Two turbines/one per train (S)
OR - Four turbines/one per compressor (D)
Electric Motors - Four motors/one per compressor (D)

Fig 8.1: Equipment Configuration and System Layouts for the Compression Stations

DECISION AREA : CHOICE OF COMPRESSION P. MOVERS

| VARIABLE | STATES | |
|-------------------------|---------------------------|--------------------------------------|
| Technology type | Gas-Turbines (G.T.) | Electric Motors (M) |
| Equipment Configuration | Single unit/train (S) | Two units per train (D) |
| Plant Layout | Layout "A" See Fig 8.1 | Layout "B" See Fig 8.1 |
| Energy System | Regenerative cycle (R) | No-Regenerative cycle (open) (NR) |
| | | |

* Both options bars (1) and (2) are due to technical infeasibility.

Fig 8.2: Systemic Breakdown of the Selection of Compression Prime Movers Case

- Option 1 - (G.T., S, A, R) (see Fig 8.2 for these symbols)
- Option 2 - (G.T., S, A, NR)
- Option 3 - (M, D, A)
- Option 4 - (G.T., D, B, R)
- Option 5 - (M, D, B)
- Option 6 - (G.T., D, B, NR)
- Option 7 - (G.T., S, B, R)
- Option 8 - (G.T., S, B, NR)
- Option 9 - (G.T., D, A, R)
- Option 10 - (G.T., D, A, NR)

However, the consultants considered in details only the first six options (Option 1 - 6) and ignored the rest (options 7 - 10); on the basis that the costs for the excluded four options could be easily deduced from the considered six options.

Although the six options were considered by the Operators, as well as by the Planners, to be the most practical in this particular case, however, the Operators felt that the proper consideration of the excluded options would have been important in evaluating the flexibility and reliability of the options, and therefore should have been included. They also expressed surprise about the non-mention of other types of technologies such as: Steam turbines; Gas engines; Diesel engines and Hot Gas expanders, and, although they appreciated that most of these types suffer from capacity limitations and, in case of Steam turbines, limitations due to the need for treated water, however, they felt that these types should have been considered, albeit briefly, and, if not, the reasons for their exclusions should have been stated. This was strongly felt since the Operators were very familiar with some of these types, especially Gas and Diesel engines. The Operators were also surprised for the non-inclusion of cooling system technologies for the Electric motors, the study assumed the cooling system to be Air, yet the Operators were also familiar with the reliable, and tried, water

system. The Planners also raised objections to the exclusion of the water version, because the supply of Air cooled Electric motors, as well as the Gas turbines, will be exclusive to the western industrialised countries and will automatically exclude all industrialised socialist countries who manufacture neither Gas turbines nor Air cooled Electric motors. This limitation on source of supply ran counter to the national guidelines of striving for maximum diversity of possible suppliers.

The above objections about the range of considered options, were raised after the submission and distribution of the study report. Most of these objections could have been avoided if the following features of the options generation phase, in the proposed integrative methodology, were followed:

- (1) Amplification of the known sets of options, if carried out consciously and systematically, would have ensured the inclusion of all possible technologies and their relevant systems. The process of structuring the decision situation into decision areas and relevant variables (see Fig 8.2), and of consciously ignoring all constraints, will ensure that the technical experts will not be able to reduce too early the available sets of options. SCCOP should have asked the consultants to prepare a list of all possible options with a brief description of the characteristics and major aspects of each, this comprehensive list should have been the basis for discussion involving SCCOP, the consultants, SPO and INOC. When the author investigated the possibilities of adopting such a procedure, all concerned expressed no objection, indeed some, especially those in SPO, were enthusiastic about its application.
- (2) The attenuation of the list of options was not carried systematically. However, by adopting the above amplification step, it would be necessary to adopt this attenuation step to ensure that only viable and practical options will be considered in detail. Technical feasibility

usually ensures that a lot of options will be eliminated early and easily. However, by systematically listing the national, sectoral and organisational policies and guidelines that are relevant to the decision situation, the filtering of the options could have been carried easily and with the participation of all the actors, and it would have triggered a policy dialogue if that was felt necessary. This would have easily avoided the exclusion of the Water Cooled motors; since the diversification-of-suppliers policy would have been one of the relevant policies. The systematic consideration of the environmental and system factors would have served the same purpose as the policy filtering and would have actually served to reduce the actual number of options evaluated; by deciding early that the consideration of the Regenerative cycle is not necessary since it is a practical absurdity in the Iraqi environment (according to SPO 3).

The implementation of the above two steps is quite possible in the Iraqi oil sector, since the organisations concerned have a long history of interactions and consultations. However, what is required is a conscious and structured approach that allows more time, attention and effort to be given to the task of problem structuring and to avoid "rushing" to deal with details. In a developing environment such as Iraq, this could only be implanted by clearly laid out procedures and guidelines, especially at the early stages. This could easily be done in the Iraqi oil sector, especially due to the prevalent discipline and central control, with the precondition that the high levels of organisational hierarchies adopt and initiate these required procedures and guidelines.

At the end of the above phase the consultants would have a scrutinised list of options that are compatible with established policies and guidelines; satisfy established threshold levels and standards; are suitable to be implemented within the ongoing system and, above all, have been discussed with, and filtered by, all

the actors relevant to the decision situation.

8.4 OPTIONS EVALUATION

The evaluation of the six options was carried out by the consultants according to the following bases (which were agreed directly with SCCOP in May 1978):

- (1) The evaluation to be made in terms of cost, which includes initial spending for installation, operating expenses and maintenance costs during a ten-year span of time.
- (2) Costs to be based on 1978 prices, and future costs are to be normalized to 1978 using a 10% interest rate and 5% cost escalation rate for maintenance, personnel and energy costs. Operating hours in each year are 8000 hours.

Table 8.1 shows a summary of the costs (at 1978 prices) of the six options, in ranked order. Based on these results, the consultants recommended option 2, which was ranked second, this preference, on the first rank, was due to the simplicity of the open-cycle turbine compared with the regenerative-cycle type, which would also lead to higher availability. The report also briefly mentioned the general advantages of the Gas turbines options, as compared to the Electric motors, to back up its recommendations.

The report became the subject of fierce debate between the Operators, Planners and the Implementors (the consultants participated in the role of experts only, providing technical advice, data and opinions - all through SCCOP). The basic objections of the Operators and the Planners (and indeed even among some of the Implementors at SCCOP as well) were that the analysis should not have concentrated on the criterion of cost alone, and that other criteria should have been considered and fully analysed prior to selection. The relevant criteria that were put forward and the attitudes of the actors to each of them, were as follows:

Content has been removed for copyright reasons

Source: Technical management of the SPO / INOC - Basrah, Iraq.

Table 8.1: Prime Movers Selection Case - Summary of Options Costs (Ranked in ascending order)

(1) Cost: Although questions were raised about the bases for energy and maintenance costing, the interest rate and the escalation factor, however, there was general agreement about the cost figures and their divisions. The Planners regarded the capital component of the cost as the most important since they were anxious to stay within the capital budget for the project; which they had estimated in the first place. The Implementors were in agreement with the Planners because they wanted to stay within the allocated budgets. These attitudes, of the Planners and Implementors, were inspite of the general liberal attitude towards capital expenditure at that time (1978). But, both felt that adherence to budget allocations was one of the principal measures against which their performance would be measured. The Operators, although appreciating the importance of this criterion, gave it scant regard, since they felt it was not their problem. The Arbiters wanted the project to be implemented within the allocated budget, but they were ready to sanction revisions if warranted.

(2) Completion Time: This was the vital criterion for the Planners and Implementors. The whole project was regarded as a vital strategic project and every day that passes, millions of dollars worth of energy would be burnt away. Hence, the whole project was implemented with a close follow-up by the political leadership. Also, any delay would cause vast amounts of money, which were allocated to the project by the central planning agencies, to be frozen as unspent and hence depriving alternative opportunities that otherwise would have been possible. This pressure was reflected in the Arbiters attitude to order critical items early, a fact which led to the study in the first place. The long delivery periods associated with the Gas turbines options might affect the project being completed in time, but, on the whole, all the six options were assumed to satisfy this criterion. The Operators were totally indifferent to this criterion, and because of the pressure of work prevalent then, actually preferred to delay the completion.

(3) Flexibility and Reliability: These criteria were mentioned briefly in the consultants' study, yet they were regarded as vital by the Operators, who wanted the maximum possible flexibility and reliability of equipment and systems to be aimed for. Questions such as standby provisions; maintenance modes; interdependencies of systems; standardization of equipment; and present experiences and expertise, were vital to them because they are related to the objective of trouble-free and smooth operational phases. The Planners and the Implementors were concerned only to provide equipment and systems that were adequate for their tasks and not to especially endeavour to make the Operators' life easier, and they were generally content to follow engineering standards and practices that were prevalent in the industrialised countries. The Arbiters, on the other hand, were more sympathetic to the Operators stand, but with the provision that it should not drastically affect the completion time, and to a certain extent, the budget of the project. It is worth mentioning that after the start of the war, these criteria assumed supreme importance especially for the Arbiters.

(4) Manpower: This criterion was not mentioned at all in the report, yet it was the overriding criterion as far as the Operators were concerned. This was due to the great difficulties they were experiencing in the recruitment and training of Iraqi personnel possessing vital scientific and technological skills. The Operators in general pushed for options that required less skilled manpower for maintenance and operation, hence their early rejection of the regenerative-cycle Gas turbines. They also advocated the adoption of labour-saving techniques and systems with particular emphasis on simplicity and familiarity. However the Operators were divided among themselves when dealing with options that would involve conflicting requirements for certain skills. In the prime movers case the principal relevant skills, for operations, development and maintenance, were

- Electrical Engineers and Technicians

- Instrumentation and Control Engineers and Technicians
- Mechanical Engineers and Technicians
- Operations Engineers and Technicians.

Hence, every concerned functional department within SPO was advocating the options that would entail the least eventual burden on it, in providing trained and skilled personnel for operation and maintenance; the Electrical Department was advocating the Gas turbines options; the Instruments and Control Department, the Electric motors options; the Mechanical Engineering Department, the Electric motors options and the Operations Departments, the Electrical motors options. However, internal discussions within SPO resulted in the top management recommending the Electric motors options since, it was felt, that it would represent less of a burden on the Operators. This choice did not adequately reflect the relative difficulties experienced in the recruitment of the skills, since no systematic attempts to assess these difficulties were carried out. The Personnel Department in SPO could have provided figures reflecting the proportion of each skill allocated by the central agencies, to the total demanded by SPO, over the previous five years (indeed the Commission for Manpower Planning in the Planning Ministry, assess nationally the scarcity of each skill by adopting the same procedure). These figures would have produced the following ranking for the vital skills, in descending order of scarcity:

Electric Engineers

Instrumentation and Control Engineers

Instrumentation and Control Technicians

Mechanical Engineers

Operations Engineers

Electrical Technicians

Mechanical Technicians

Operations Technicians.

However, we could only speculate about what the choice of the Operators would have been if they had carried the above exercise then.

The Planners and the Implementors were totally indifferent to this criterion. Since the Planners' position is immune to the manpower requirements at later stages and the Implementors' tasks during the implementation stages were to be carried out, anyway, by foreign contractors. The Arbiters appreciated the importance of the manpower criterion, but they were also aware that: Operators tend to exaggerate their problems; no quantifiable estimates, that could adequately reflect the evaluation of the options as related to the manpower criterion, had been produced; and, all the objections that were voiced were based on gross "guesstimates" and raised many disagreements, even among the Operators themselves.

The attitudes of the Actors towards the above criteria (which were considered to be the most relevant for the case example) are summarised in Table 8.2. The table shows the ranking of the criteria in descending order of importance, as rated by each actor (an "actor" refers to an organisational entity acting as a homogenous decision maker, inspite of internal disagreements).

The consideration of the above criteria within the original study, could have been easily achieved if SCCOP had conducted a series of discussions and interactions with the relevant bodies, and produced a short report detailing the proposed terms of reference of the consultants' study; detailing the criteria according to which the feasible options would be evaluated. These terms of reference could have then served as a basis according to which the consultants would conduct their study, i.e. a conscious and systematic effort to tackle the task of criteria selection; to ensure that important criteria will be considered adequately and to avoid the present practice of concentrating wholly on the

| ARBITERS | PLANNERS | IMPLEMENTORS | OPERATORS |
|---------------------------|---------------------------|---------------------------|---------------------------|
| Completion Time | Capital Cost | Capital Cost | Manpower |
| Flexibility & Reliability | Completion Time | Completion Time | Flexibility & Reliability |
| Manpower | Flexibility & Reliability | Flexibility & Reliability | Operating Cost |
| Total Cost | Manpower | Manpower | Completion Time |

Source: Interviews conducted by the author, NOV. 1983 - JAN. 1984.

Table 8.2: Rankings of Criteria by the Relevant Actors -
The Prime Movers Selection Case

economic criteria. However, because of time and costs considerations, the list of relevant criteria would then have to be restricted to the most important, and the more strongly advocated, ones.

The above suggested process follows the "Evaluation Criteria selection" step in the proposed methodology.

For the evaluation of the impacts of the options on the selected criteria, the consultants, by depending on their vast technical expertise and by interacting with the relevant agencies, could have quantified the quantifiable (e.g. cost) and given indications about the qualitative (e.g. Simplicity of Operations). These results would then have been circulated to all the actors involved. The actors would then supplement these impacts with details about factors which affect each criterion, e.g. for the Cost Criterion, the Planners would insert information such as: attitudes towards capital v's operation costs; the ranges of preferred values; attitudes of the financing agencies to revisions in allocations, and for the manpower criterion, the Operators would seek information about: the scarcity of the required skills; the ratio of non-national to national personnel in each skill category already working and the limits on that ratio; skill categories covered by policy that they should only be filled with national personnel; etc.

If agreement cannot be reached between the actors on the preferred choice, even after such an extensive evaluation and analysis, then the use of the AHP process, to construct a ranking vector for each actor, could be adopted. The construction of the pairwise comparison matrices could be coordinated by SCCOP for the Operators, Planners and themselves, and the ability, knowledge, expertise and tools necessary for the matrices' construction, and the deduction of the ranking vectors, could all be tapped within the present set up of SCCOP (similarly for the Planners at INOC headquarters). The construction of the "Ratio" matrices

is a straightforward quantitative exercise if the information is available, however for the "judgemental" matrices the process is complicated by the difficulty of actually getting the actors to measure comparisons based on "Relational" statements. But, all of them, when they were informed of what is involved, were very positive about its applicability and considered it a worthwhile exercise if it helps to structure their preferences and attitudes. They were (especially the Operators) very enthusiastic about the prospect of carrying this exercise after the relevant criteria had been duly analysed and the results circulated.

8.5 OPTIONS SELECTION

After a short period of discussion of the study, the Planners at INOC presented a short report to the Arbiters (the higher committee). This report contained a summary of the salient points of the study and the issues raised by the Implementors and the Operators. The Arbiters, according to the recommendations of the Planners, decided to choose option 5, because: the capital cost component of 11.3 million dollars was rather low (completely ignoring the astronomical energy cost on the basis that the fuel was readily available from the oil fields themselves); Option 5 is superior in flexibility and reliability to option 3; the Electric motor technology is easy and familiar; and, the responsibility for providing the required electrical energy lies with the National Electric Authority, hence reducing the burden on the oil sector.

The argument here is not whether the choice was appropriate or not, but, the way it was taken. The Arbiters were briefed by the Planners only, who were depending on a study based on a detailed analysis of only one criterion and on general comments about the issues raised by the Implementors and the Operators.

The Arbiters regarded the advice of the Planners as the most appropriate under the prevailing circumstances. Although they appreciated the importance of the choice, since it would affect all future prime movers choice decisions due to

standardization and familiarity, however, they realised that they could not ask for a new study because of time and could not initiate an alternative process to improve interactions, discussions and conflict resolution because: firstly, they were not aware of the need and, secondly, they did not possess an alternative. Some members of the committee, when probed by the author, expressed their preference for any process that resulted in them being aware of the positions and attitudes of the other actors. This, in their opinion, would help them to identify the major obstacles to agreements and consensus, and to further explore the reasons for these obstacles. They especially appreciated the need for a vector reflecting the criteria importance for each actor. As far as the ranking reference vectors for the Arbiters, they suggested that it is difficult to construct such a vector in a committee setting of high standing personnel, and they felt that the preferred way would be to leave the construction of such a vector to the secretary of the committee - resulting directly from the discussions and deliberations of the committee - and then the secretary would brief them about the discrepancies between the Arbiters' vectors and the vectors of other actors.

The above assessment of the feasibility of the methodology in the prime movers selection case concentrated on the advantages and improvement that could be achieved by adopting the proposed integrative methodology. However, the following section will deal with the tasks, issues and factors that are related to the actual implementation of the methodology in the environment of technological decision making in the Iraqi oil sector.

8.6 THE IMPLEMENTATION OF THE METHODOLOGY

The previous three sections demonstrated the potential usefulness and the applicability of the integrative methodology in the prime movers selection case within the specific environment of the LPG project. However, the

implementation of the methodology in any choice situation, and its adoption as part of any decision making process, necessitates the prior accomplishment of the following tasks:

- The decision makers have been introduced to, become familiar with and have adopted the methodology as a positive and effective aid to decision making.
- An operational procedure has been established that ensures the initiation and applications of the methodology to relevant choice situations.

The execution of the above tasks, within any context, is largely dependant upon the states of the following closely related environmental factors:

- The prevailing decision making culture.
- The prevailing organisational structure.
- The existing informational environment.

The feasibility of the accomplishment of the above implementation related tasks, and their possible operationalisation forms and procedures, will be evaluated according to the prevalent states, and forms, of the above environmental factors in the context of the Iraqi crude oil industry. This will be done in turn.

8.6.1 The Introduction of the Methodology: The introduction of the methodology in the decision making process of the Iraqi oil industry covers the issues of the feasibility of its adoption by the decision makers, and, if so, the strategies that are recommended to ensure its proper introduction to the relevant decision makers.

The decision making culture required for the adoption of the integrative methodology ought to facilitate, and encourage, the adoption of procedures and methods that aim to ensure that decision processes are based on structured and

systematic approaches; and that the decision making process is consultative participative and open.

The attitude of the Iraqi managers to systematic analysis and structuring is very encouraging. This stems from their healthy respect for everything that is based on scientific methods and procedures, however, they tend to associate this mainly with quantification and the use of computers. INOC 4 elaborated the reasons for the preference of quantitative approaches, thus:

"If a decision is based on facts and figures, then you can always defend it. Qualitative aspects are usually speculative, unrecorded and inaccurate, therefore they will not serve as justification for the choice."

The methodology's approach to turn qualitative evaluations into figures, by the use of pairwise matrices and eigen vectors, would stand it in good stead with the Iraqi managers; especially if the results are turned by the use of computers, since respect for the role of computers is quite astonishing among Iraqi managers, (a quite common phenomenon according to many authors, such as Cleland & King (1983), Porter et al (1980) and Goodman & Love (1980)). SCCOP 4 reflected this respect when he stated that:

"Results produced by using the computers are usually treated with great respect. It is the easiest way to show that scientific methods have been used in reaching the decision."

(However, this respect should not camouflage the methodology's true purpose of aiding the decision makers to make enlightened decisions, and not to make decisions on their behalf; this role should be explicitly explained during the training and familiarization phases and stated clearly on any forms or software used for the purpose of the implementation of the methodology).

The consultative dimension of the methodology may run counter to the natural tendency of the Iraqi manager to act, and be seen to act, decisively. It may also be obstructed by the high degree of status consciousness usually displayed by the Iraqi managers. SPO 4 elaborated these tendencies, thus:

"It is important for us to appear decisive, authoritative and powerful. This is expected from us by our subordinates. When they come to us with a problem, they expect us to decide and not over hesitate. In my opinion, it is more vital to look decisive and powerful than being right, although the two may be closely linked."

However, these tendencies are usually mellowed by the fear of failure and the risks of unpopularity and of bad reputations. SPO 5 reflected this fear, thus:

"If a decision proved to be wrong, costly or inappropriate, then it is the top management who get the blame and face the consequences, and not the experts and the analysts. Failure is usually magnified, yet success may pass unnoticed."

An important factor contributing towards better consultation and participation is the continuous advocacy by the political leadership of the need for participative planning and consultative decision making and the necessity of paying due attention to the users and the operators (ABSP, 1974; ABSP, 1982), with the implication that: mistakes occurring after proper consultation and participation would be forgiven and regarded as part of the learning process, but mistakes occurring after the use of an autocratic decision making procedure would be regarded as a serious case of mismanagement which should result in severe reprimands (ABSP, 1982).

On the whole, it is felt that the emphasis of the proposed methodology on consultation and participation will enhance its applicability in the Iraqi oil environment.

The organisational structure of the oil industry is very conducive to the integrative methodology, because of the clarity of differentiation between the identity and roles of the actors in the decision making process. The unique feature is that the Implementors (SCCOP) are direct participants in decision making; by virtue of their being part of the Oil Ministry and participants in the higher committee (Arbiters). Thus, the Implementors do not have to follow the instruction of the Planners and the Operators, as is usually the case in the general

customer-contractor arrangement. However, this has given rise to complaints by the Planners and the Operators, who accused SCCOP of acting, sometimes, as the owner instead of complying with their requests; and of pursuing its own objectives, which are usually aimed at enhancing its abilities, expertise and standing, and relegating downward the main objective of sound implementation of the project. The Arbiters acknowledged these complaints, but they also justified SCCOP behaviour, according to INOC 4, thus:

"The enhancement of the abilities of SCCOP, so as to achieve the ability of implementing major projects directly, is one of the main objectives of the oil sector and closely watched by the political leadership. Therefore, if an experience with a technique or a system is thought to be advantageous by SCCOP, then acquiring such an expertise should be a criterion that has to be considered when choices are made."

However, on the whole, no insurmountable organisational factors could be identified which would rule out the adoption of the methodology. On the contrary, it should contribute to the improvement of the coordination between, and the higher awareness of the concerns of, the various organisational entities involved.

From the informational point of view, the Iraqi managers have grown accustomed to taking decisions in an information starved environment; relying mainly on their awareness, experience and intuition. The methodology utilizes this ability in its judgemental processes, and also helps to systematically synthesize known data and information on the one hand, and to identify areas in which information should be systematically processed in the future, on the other. This inbuilt characteristic of the methodology, of being applicable at any informational level, is in tune with the attitude of the Iraqi decision makers towards the informational requirements of decision making; expressed by INOC 5 thus:

"We would like to have adequate information prior to taking vital decisions, however, we cannot usually afford such a luxury. Decisions are taken because they are required to be taken, irrespective of whether the information is adequate or not."

The flexibility of the methodology's informational requirement also enhances its applicability, SPO 5 stated the reasons for the nonadoption of many sophisticated techniques and methods that were intended as aids in the decision making process, as:

"Many techniques and methods have been introduced for our use, but most, if not all, of them demanded levels of informational requirements that were above the capacities and abilities of the existing information systems. This caused their speedy abandonment. Any method or procedure that aims to be adopted should not demand extensive and accurate information as a prerequisite for its implementation, but should be applicable with the existing available information and develop as the level and extent of available information improve."

Hence, on the whole, the proposed methodology's informational dimension matches the prevailing informational environment in the Iraqi oil sector.

The process of introducing the methodology to the decision making system of the Iraqi crude oil industry is recommended to be entrusted to the General Establishment for Oil Training (GEOT) (which has the primary responsibility of coordinating personnel training and management development throughout the oil sector). GEOT has accumulated wide experience in the training of Iraqi managers on techniques such as economic evaluation of projects (including C.B.A.), Critical Path Analysis (C.P.A.) and numerous business computer packages. Hence, they should find no problem in coordinating the introduction of, and the training on, the methodology. GEOT 1 reflected this when he said:

"The proposed methodology could easily be handled by GEOT, and I envisage no difficulty in providing the necessary software, seminars and courses to ensure that all relevant managers are familiar and conversant with it."

GEOT 2 concurred and actually suggested a process for its introduction:

"Three times a year, GEOT runs a two week management development course for higher management, and a four week development course for middle level managers. The teaching of the methodology could easily be integrated within these courses as an ongoing training and familiarization process."

GEOT 1 actually expressed enthusiasm for its inclusion as part of the management development courses for its academic value alone, and he saw no difficulty for GEOT to produce the necessary software to ensure its proper teaching.

However, all the interviewees have expressed the opinion that the backing of the high-level management is necessary to ensure its adoption and introduction (a quite commonly quoted precondition e.g. Cleland & King (1983)). GEOT 3 indicated that if the high level managers were familiarized with the methodology; through either the management development courses, specially designed courses or series of seminars and lectures, then, the chances of securing their backing will greatly improve if they perceive it to contribute to the improvement of the quality of decision making. INOC 5 reflected the readiness of the high level management to give this backing when he said:

"We are always on the lookout for ways and means that improve the quality of our decision making. We are also very willing to adopt modern techniques and methods and to use them to appraise their usefulness. Hence, if our managers have become familiar with a technique that could improve their choice and selection process, then we are willing to back it with instructions that it should be used and adopted; providing of course that the necessary back up training and software are already established."

Hence, in conclusion, the process of introducing the methodology to the Iraqi oil industry's decision making system may be summarised as follows:

- (1) Familiarizing the decision makers at the appropriate levels with the methodology, especially its integrative consultative and participative characteristics - GEOT is the suitable vehicle for this in liaison with the training and development departments in the respective organisation.
- (2) Preparing and distributing the required software (computer programs, booklets, forms) for the implementation of the methodology - GEOT is capable of executing, or coordinating, this task.

- (3) Securing the backing and support of high level management - GEOT to carry out this task mainly through the training and familiarization of these managers. This backing should be eventually translated into clear instruction from the top management that the methodology should be adopted and applied when necessary.
- (4) Establish a process for operationalising the methodology; this is the subject of the next section.

8.6.2 The Operationalisation of the Methodology: If the methodology has been introduced to, and integrated with, the decision making system of the crude oil industry, then, the remaining requirement is the formulation of procedures and guidelines that cover its operationalisation.

The decision making process which envelops the implementation of the methodology would entail the execution of the following tasks:

- Appraisal of the decision situation
- Triggering of the methodology, if deemed necessary
- Application of the methodology
- Choice and decision making
- Intervention and change.

The first three of these tasks will be outlined, in turn.

(a) Appraisal of Decision Situations:

Throughout the evaluation of the feasibility of the methodology, it has been assumed that the methodology would not be initiated unless the decision situation is vital, complex and controversial and these situations were assumed to be few and far between; the prime movers selection case falls in the above categories, especially in setting the industry's position towards such an issue which involves large investments, affects future selections and trends and involves vital policy

issues about technology policy and national, and sectoral, energy profiles.

In the context of major technological projects, the execution of the appraisal task usually falls within the jurisdiction of the actors having the major responsibility for the project at that particular point of its life cycle. However, most of the vital decision situations are expected to arise during the "conceptual design" stage of the project life cycle. Hence, the appropriate responsibility for the execution, or the coordination of the execution, of this task should be entrusted to the Planners, who are the major actors during this stage. In such situations, the Planners could identify the major decision situations which could provoke controversy, require huge investment, or set a trend, and solicit the opinions and comments of the other actors (this process is done presently after the completion of the conceptual designs). The results should then be presented to the Arbiters. The Arbiters would then decide on which of the situations require the initiation and application of the methodology; the Arbiters may base their decision on either their wish to review a major area of practice; the amount of resources involved, making it vital to be absolutely sure that they make the right decision; or the vehement stand taken by one of the principal actors.

It is recommended that the above procedure should be initiated during the early phase of the "conceptual design" stage of every major technological project, and not at the end of it. This will avoid the necessity for expensive, and time consuming, revisions and re-evaluations and will contribute towards producing a design that is more acceptable and implementable.

The Planners at INOC agreed that the above proposed procedure is practical, useful and implementable.

(b) The Triggering of the Methodology

Since the final say in major decision situations lies with the Arbiters, then they should be the ones who decide whether the methodology be used or not. But,

before triggering, the Arbiters may require from the major actors of that stage (e.g. Planners during the "Conceptual design") an assessment of the time and resources required for the application of the methodology. The Arbiters should then issue clear terms of reference to the coordinators of the application (usually the major actor at that point of the project life cycle), and clear instructions to the other relevant actors to cooperate fully with the coordinators of the application. The appropriate terms of reference should identify the principal actors and the relevant evaluation criteria as well as other implementation issues, such as duration and budget.

The higher committee possesses the requisite authority to implement the above procedure and some of its members, when probed, saw no difficulties in its execution. The structure of the higher committee also allows the possibility of the initiation of the methodology being requested by any of the principal actors via their representative on the committee, however the actual application should not commence unless the committee approves these requests.

(C) The Application of the Methodology

The application of the methodology to major decision situations, requires a high degree of organisational coordination between the various entities and units, and a high degree of organisational "glue" that ties them together and forms their approach to decision making. This "glue" may be enhanced by a conscious effort, led by the Arbiters, to increase awareness, consultations and interactions among the actors and between them and their associated environments. Also, the prevailing control and organisational discipline should help towards the achievement of this "glue". The organisational "glue" may also be enhanced by designating the Planners to take over the project as Operators upon its completion, hence, automatically enhancing their awareness and concern of the issues that are relevant at the operating stages and ensuring that criteria relevant

to post-completion stages will be considered and evaluated (Cleland & King (1983) actually list this approach as one of their recommendations). In the Iraqi oil industry this approach has been used sometimes, but lately it has been rarely used; mainly because, according to INOC 5:

"Project management and planning is a rare skill in Iraq and very few people are properly trained for it. Hence, it is necessary to move these people from the planning of one project to another, and although the suggestion is good, however, under the present load of project it is impossible to implement."

Nevertheless, most of the interviewees have expressed the opinion that the present system of coordination and consultations between the actors in the oil industry, is quite capable of carrying the extra burden required for the application of the methodology.

The informational requirements for the application of the methodology could be handled by the existing management services departments within SCCOP, INOC and SPO. The present information system handles very extensive information and data requirements dictated by, among others, the Ministry of Planning. These requirements include fine detail about all the aspects of projects under construction, and they take the form of standardised forms that are circulated among various organisations. Indeed similar forms could be designed to cater for the listing of the relevant criteria and their associated policies, cut-off values, standards and guidelines. These forms could be coordinated and prepared, during the "conceptual design" stage, by the Planners, discussed with the Arbiters and circulated to other actors to serve as basis for the filtration and evaluation of options.

The operationalising of the AHP has been tackled by many authors; Saaty (1980) suggested a questionnaire form with the scale being represented as a graded line; and, Sinuany-Stern (1984) also adopted a questionnaire form but with direct entry figures for pairwise comparison. It has already been indicated that the

crucial step is the ranking of the relevant criteria by the actors (since the ranking of options on the criteria will consist mainly of non-controversial judgemental and ratio values). These relevant criteria are usually small in number (four in the case example), therefore the pairwise comparison between these criteria will be a relatively easy task to implement, and if the Sinuany-Stern format were adopted, the sample of the comparison form would be as shown in Fig 8.3. These forms may be filled by the various project coordinators after discussions with other units within their organisations and the final version should be cleared after circulating it among the participants for comments and adjustments. The production of the eigen vectors and ranking tables could be easily coordinated by any of the organisational entities when acting as coordinators of the application. Computers, which are becoming much more familiar and widespread lately, may be utilized to run user-friendly packages to facilitate the application. The packages could be done directly, or coordinated, by GEOT and the training on them could be integrated as part of the familiarization process of the methodology outlined in section 8.6.1.

It is anticipated that the application of the methodology will help to identify the areas in which information should be improved, or systematically processed, for future applications. The following-up of this important task could be coordinated by the respective management services departments and executed by the functional departments each according to its specialization. The eventual improvement and streamlining of the acquired information, plus the experience and the familiarity that would be gained by adopting and applying the methodology to real life situations, will greatly enhance its contribution to the improvement of technological projects decision making in the Iraqi oil industry

The above section has demonstrated the possibility of utilizing the prevailing cultural, organisational and informational environments, within the

Our goal is to ensure the sound planning and implementation of the vital LPG project. In the matrix below please compare the importance of each of the criteria to the achievement of the above goal as compared to other criteria. One member of each pair must be assigned a base weight of (1). The other member of the pair should be assigned a value of (1) (equality) to (9) (absolute dominance) according to your judgement of its relative importance to achieve the goal.

PAIRWISE COMPARISON OF CRITERIA

| | COST (C) | (C.T.) | (F/R) | (M/P) |
|---------------------------------|----------|--------|-------|-------|
| (C) COST | | | | |
| (C.T) COMPLETION TIME | C.T | C | | |
| (F/R) FLEXIBILITY & RELIABILITY | F/R | C | F/R | C.T |
| (M/P) MANPOWER | M/P | C | M/P | C.T |
| | | | M/P | F/R |

Fig 8.3: Sample Form for the Construction of Criteria Pairwise Comparison Matrix - LPG Case

Iraqi oil industry, to ensure the appropriate introduction, application and development of the proposed methodology, and to achieve its smooth integration with the existing decision making processes.

CHAPTER 9

DISCUSSION AND CONCLUSIONS

In the context of technological projects within a centrally controlled developing environment the multiple agencies, termed as actors, were identified by analysing their responsibility profiles over the stages of the project. The actors were identified as:

| | |
|--------------|-----|
| Planners | (P) |
| Implementors | (I) |
| Operators | (O) |
| Arbiters | (A) |

A methodology to integrate the consideration of the criteria relevant to the above actors has been proposed. It covers the entire decision making process, from options generation to choice and decision making.

The methodology stipulates that, when differences between the actors cannot be resolved, and/or the decision situation warrants special attention and evaluation, the Analytical Hierarchy Process (AHP) be adopted as a tool to reflect the actors' judgements about the criteria and the options involved, and to outline to them their differences and the range of judgements they have exhibited. Hence, it will utilize the differences between the actors as a trigger for an interaction and discussion effort. This will improve the tuning of the various components of the organisation to the aims and goals of the organisation as a whole, thus enhancing organisational learning as well as facilitating decision making.

An extensive assessment of the methodology's feasibility, based mainly on a technological project within the Iraqi oil industry, indicated that the methodology would be useful and implementable.

9.3 GENERAL DISCUSSION AND CONCLUSIONS

This discussion will cover the three most important, and closely related, aspects:

- The principal features of the methodology i.e. its special characteristics.
- The effectiveness of the methodology i.e. its advantages and potential contributions to improved decision making.
- The suitability of the methodology for decision making in developing countries in general.

These issues will be discussed in turn.

9.3.1 Principle Features of the Methodology: These may be enumerated as follows:

- The methodology is a realisation of the systems approach.
- The methodology adopts practicable and simple tools and methods.
- The methodology adopts an innovative approach to problem structuring and subsystem identification.

The Systems Approach, as a concept, has been defined and described by many authors (e.g. Beer, 1979; Churchman, 1979; Jenkins, 1969; Dror, 1971). However, if the essential meaning of the concept is considered, then the methodology may be regarded as a realisation of the systems approach, for the following reasons:

- (1) The extent of the options considered; the options generation process of the methodology adopts a structuring and specification procedure that is based on a sequence of an amplification step, with total absence of constraints, and a filtration step, which relates the decision situation to its environment and context. Both the amplification procedure and the filtration process are derivatives of the systems approach (Ackoff, 1977; Friend & Jessop, 1976).

(2) The multiplicity of the evaluation criteria; although the original motive for the formulation of the methodology was the consideration of the manpower criterion, the approach adopted in the formulation of the methodology was that no criterion could be considered in isolation, and that any methodology intended to act as an aid to decision making should facilitate and encourage the consideration of as many criteria as possible. Hence, the methodology enlarges the scope of consequences to be appraised when evaluating different alternatives, which is a manifestation of the systems approach (Dror, 1971; Cleland & King, 1983).

(3) Qualitative, as well as quantitative, appraisal; the methodology facilitates the appraisal of options impacts and criteria weights whether they are quantifiable or not; by adopting the 1-9 scale when dealing with judgemental and qualitative measurements. This characteristic is conducive to the widening of the scope of analysis and appraisal which is a basic tenet of the systems approach. Indeed Cuenod (1980) identified the main purpose of the systems approach in situations involving technological choice, thus:

"The main purpose of the systems approach is to establish a link between engineering professions and social and behavioural sciences to bring forth between them a fruitful dialogue."

The quantified appraisal of qualitative factors and judgements would enhance this interaction and dialogue.

The tools and methods, adopted for the operational processes of the methodology, are embedded within the existing literature. The recommended methods and processes were not chosen because of their analytical elegance, but because of their practicality, clarity, feasibility and behavioural suitability as

substantiated by the literature. The principles according to which the methodology was formulated led to the choice of Saaty's AHP as the principal operational tool during the options evaluation and selection phases. The AHP was chosen because of its simplicity, operationality, and above all, its behavioural suitability; indeed Wind & Saaty (1980) have indicated that managers find the AHP to be interesting and of value, in forcing them to examine relationships which usually are left unexamined. The AHP was also recommended as the basic method for evaluating the impact on, and the importance of, the manpower criterion, hence strengthening the synergy and increasing the familiarity of the organisational units with the AHP and its operational requirements.

The methodology's structuring and identification approach is based on the premise that actors within the decision making systems should be the ones who actually take the decisions. Therefore, if a methodology aims to tackle multiple criteria in decision situations, it has to ensure the inclusion of actors with diversified objectives and concerns, and hence multiple criteria domains of interest will be involved in the decision making. Many methodologies have suggested the identification and the inclusion of actors, but the innovative characteristic of the methodology is the actual identification of the actors in the general context of technological projects. The actors were identified according to their responsibility profiles during the project's life cycle. The responsibility profile method provides means for deducing the actors roles, objectives and concerns. The methodology also includes processes for the structuring of the actors' attitudes and judgements; for their interaction and negotiation; and for conflict resolution and decision making.

Hence, the methodology is a contribution to the scattered, and scarce, literature dealing with the identification of, and conflict resolution among, relevant actors in situations that involve multiple decision making agencies as well as multiple criteria.

9.3.2 The Effectiveness of the Methodology: Hinloopen et al (1982), who have made extensive use of multiple criteria models in regional planning, have suggested that multi-criteria approaches to decision making should serve the following aims:

- (1) Systematic classification of factual information.
- (2) Better insight into various judgements (e.g. the assessment of the relative importance of the different criteria).
- (3) Inclusion of differences in interest and/or political views.
- (4) Emphasis on the openness of the decision making process.
- (5) Meaningful reduction of the available information.
- (6) Aid to better considered decisions.
- (7) Provision of a more justifiable basis for decisions.
- (8) A more structured decision making process.

While this was not taken as a precise list of objectives for the proposed methodology, it does serve as a good description of the concerns and goals in mind when the methodology was formulated. However, to ascertain the extent to which these aims are achieved, the methodology should be practised for a period in real-life decision making situations and the results of these applications assessed.

Unfortunately, it is impossible to enforce the implementation of the methodology on any organisation for the purpose of substantiating whether the methodology achieves its aims or not; this difficulty is encountered in all research dealing with strategic planning and decision making. Nevertheless, the extensive feasibility assessment conducted in the Iraqi oil industry indicated that the methodology should provide a useful framework for the discussion of the decision situation, the synthesis of the available information and the incorporation of value judgements about the relative importance of different factors and criteria. It also indicated that the application of the methodology would be beneficial in providing a more justifiable basis for a decision. However, its major

contributions would be: its possible function as a learning tool, exploring the attitudes and judgements of relevant organisational entities; and as a stimulant for analysing the available information and identifying the directions of improvements in information that would lead to better and more enlightened decision making.

9.3.3 The Suitability of the Methodology for Developing Countries:

Bandyopadhyay & Varde (1980) and Sagasti (1972 & 1976) have summarised those factors which inhibit the application of traditional Operational Research and Management Sciences techniques and methods in developing countries, as follows:

- (1) Problems of development are complex. They are often multi criteria problems and are not understood very well or well structured.
- (2) The problem environment is seldom stable. It changes often and sometimes drastically.
- (3) There is an acute loss of relevant data.
- (4) Decision makers in governments, industry and service organisations are not very favourably disposed to the application of sophisticated operational research, quantitative methods and scientific analysis (since, apart from their complexity, they are perceived to constitute a threat to the decision makers' authority and control).
- (5) There is a communication barrier between managers and analysts, experts and scientists.

The methodology, in its basic formulation, is an attempt to deal with complexity and turbulence in a structured and systematic way. The adoption of the systems approach, and the involvement of multiple actors with diversified interests, concerns and objectives, should facilitate decision making that is rich and inherently flexible. The participation of actors whose responsibility cover the whole project life cycle should ensure that there is strong propensity to include

the "robustness" of a decision as one of the basis of choice; to cater for the expected turbulence in the environment. The judgemental processes within the methodology should ensure its application irrespective of the available information and should indicate the desired directions for its development. The unfavourable disposition of the decision makers to sophisticated decision aids should be overcome by the conceptual simplicity and operational flexibility of the methodology, since it involves minimal reliance, if any, on complicated and abstract techniques and method; hence, assuring decision makers of their overriding role in actual decision making. The basic structure of the methodology should also serve as a communication stimulant between experts and the decision makers and amongst themselves since all of these actors are assumed to be an integral part of the structure.

The methodology's feasibility assessment in the Iraqi oil industry indicated that the overcoming of the application inhibiting factors is feasible, and that the methodology may actually raise the enthusiasm of the decision makers for adopting strategies that would lead to its smooth adoption and application.

Finally, if the methodology is feasible to be integrated in the decision making process of the Iraqi oil industry; is effective in achieving its aims as a decision making aid; and, is suitable, useful and implementable, then there should be no reasons for not adopting it in similar developing environments or adapting it to suit differing ones. However, the application of the methodology to decision situations that differ from the specified one of technological project in developing countries e.g. small non-technological projects in developing countries, or large technological project in developed ones, might entail a respecification of the context which could lead to alternative identification of the subsystems and different situation structuring. Nevertheless the operational processes and tools may still be suitable and practicable.

9.4 SUGGESTIONS FOR FUTURE WORK

These are divided into:

A. General Suggestions:

- (1) More work is required in the way of developing methodologies for approaching the multiple decision makers situation. It is hoped that this area will receive more attention from researchers in the future with emphasis on real-life applications and empirical evidence concerning usefulness and applicability.

- (2) More testing in real-life problems is required for the available MCDM methods, models and techniques. The principal difficulty here is that no controlled tests are possible; a real decision cannot be made with the aid of a method and without it. Thus in order to ascertain in depth the advantage, applicability, complexity, difficulty, etc. of each method, it is necessary to consider a large variety of problems approached by the various methods, and to endeavour to draw general conclusions. Checkland (1984) has been accumulating such information about his methodology for some years, but elsewhere evidence is scarce. Whilst certain theoretical advantages may be put forward for some of the methods, it is felt that the crucial test of a successful method is that decision makers are willing to use it and are satisfied with using it. Clearly this is essentially a subjective decision, but nevertheless indicators such as frequency of use and decision makers' attitude scores may give some degree of "objective" rating.

B. Suggestions Related to the Methodology

- (3) If it is necessary to use Saaty's AHP in the options evaluation stage, then it will be advantageous to use a computer package for the simple, but tedious, data gathering and calculations involved. This might either be one specifically written for the particular project, or an adaptation of an existing package (Saaty, 1980; Hannan, 1983). It will be important in such a case to make it clear to all the actors that the computer is merely serving as a calculating device, and does not alter the process itself. This potential disadvantage should be weighed against the enhanced clarity of representation of the actors' concerns and judgements that the computer could facilitate.
- (4) The evaluation of this methodology poses the same problems already mentioned in the general case above. Real-life applications are essential in order to ascertain the effectiveness, suitability and efficiency of the methodology. A particular problem in this context is that the projects are large and are carried out over a long period of time. Thus, even if first impressions are favourable, dissatisfaction with the outcome of a project may arise some years later. The overriding consideration must remain the acceptability of the methodology to the decision makers who are using it, and so an adequate assessment of the methodology in a particular organisation might easily take some ten years, requiring close monitoring of the implementation throughout that period.

REFERENCES

Abed, T.G. and A.A. Kubrusi (1981): "A Macro-economic Simulation Model of High Level Manpower Requirements in Iraq", in N.A. Sherbiny (ed), Manpower Planning in the Oil Countries, JAI Press, Greenwich, Conn., U.S.A.

Abelson, R.P. (1976): "Script Processing in Attitude Formation and Decision Making", in J.S. Carrol and J.W. Payne (eds), Cognition and Social Behaviour, Erlbaum, Hillsdale, N.J., U.S.A.

ABSP - Arab Ba'th Socialist Party (1974): The 1968 Revolution in Iraq, the Political Report of the Eighth Congress of the Arab Ba'th Socialist Party in Iraq, January 1974, Ithaca Press, London, 1979.

ABSP - Arab Ba'th Socialist Party (1982): Central Report of the Ninth Regional Congress", (in Arabic), DAR AL-HURIYAH, Baghdad, Iraq.

Ackoff, R.L. (1957): "Operations Research and National Planning", Operations Research, Vol.5, pp.457-468.

Ackoff, R.L. (1977): "National Development Planning Revisited", Operations Research, Vol.25, pp.207-218.

Alf Baa (1983): "Interview with Mr. Taha Yasseen Ramadan, 1st Deputy Prime Minister", Alf Baa Magazine, 10-17 October, (in Arabic), Baghdad, Iraq.

Ali, A.M. (1982): The Authority of Management in the Implementation of Large Projects (in Arabic), DAR AL-QADISIYAH, Baghdad, Iraq.

Anderson, A.M. and M.D. Earle (1983): "Diet Planning in the Third World by Linear and Goal Programming", Journal of the Operational Research Society, Vol.34, No.1, pp.9-16.

Arbel, A. and R.M. Tong (1982): "On the Generation of Alternatives in Decision Analysis Problems", Journal of the Operational Research Society, Vol.33, No.4, pp.377-387.

Armitage, P. et al (1969): Decision Models for Educational Planning, LSE Studies on Education, Penguin, Allen Lane, London.

Arrow, K.J. (1963): Social Choice and Individual Values, (2nd edition), Yale University Press, New Haven, U.S.A.

Asker, K. (1982): The Environment of Initiation and Development of Industrial Projects in the Arab Countries, (in Arabic), The Arab Planning Institute, Kuwait.

Bailey, K. (1978): Methods of Social Research, Free Press, New York.

Bandyopadhyay, R. and S.D. Varde (1980): "O.R. Education and Developing Economies with Special Reference to India", Journal of the Operational Research Society, Vol.31, No.8, pp.675-687.

Bartholomew, D.J. et al (1976): "Manpower Planning in the Face of Uncertainty", Personnel Review, Vol.5, No.3, pp.5-17.

Beach, L.R. et al (1976): "Developing and Testing a Decision Aid for Birth Planning Decisions", Organisational Behaviour and Human Performance, Vol.15, pp.99-116.

Beer, S. (1969): "Planning as a Process of Adaption", in J. Lawrence (ed), OR 69 - Proceedings of the Fifth International Conference on Operational Research, 1970, Tavistock, London.

Beer, S. (1979): The Heart of Enterprise, J. Wiley & Sons, Chichester.

Beer, S. (1984): "The Viable System Model VSM : Its Provenance, Development Methodology and Pathology", Journal of the Operational Research Society, Vol.35, No.1, pp.7-27.

Bell, D.J. et al (1969) "Manpower Planning at the Level of the Firm", in C.G. Lewis (ed), Manpower Planning - A Bibliography, English University Press, London.

Belton, V. (1985): "The Use of a Simple Multiple-Criteria Model to Assist in Selection from a Short List", Journal of the Operational Research Society, Vol.36, No.4, pp.265-274.

Bennett, P.G. and C.S. Huxham (1982): "Hypergames and What They Do: A Soft O.R. Approach", Journal of the Operational Research Society, Vol.33, No.1, pp.41-50.

Bennison, M. (1981): The IMS Approach to Manpower Planning - IMS Report No.8, IMS, University of Sussex, Brighton.

Bettman, J.R. (1974): "Toward a Statistics for Consumer Decision Net Models", Journal of Consumer Research, Vol.2, pp.71-80.

Blau, P.M. (1964): Exchange and Power in Social Life, J. Wiley & Sons, New York.

Braybrooke, D. and C.E. Lindblom (1963): A Strategy of Decision, Free Press, New York.

Bunker, R. (1974): "Making Decisions in St Albans", Built Environment, Vol.3, pp.316-318.

Calpine, H.C. and A. Golding (1976): "Some Properties of Pareto-optimal Choices in Decision Problems", OMEGA, Vol.4, No.2, pp.141-147.

Camhis, M.M. (1979): Planning Theory and Philosophy, Tavistock, London.

Caplin, D.A. and J.S.H. Kornbluth (1975): "Multiple Objective Investment Planning under Uncertainty", OMEGA, Vol.3, pp.423-441.

Centre for Environmental Studies (1970): "The LOGIMP Experiment", Centre for Environmental Studies, London.

Checkland, P. (1984): Systems Thinking, Systems Practice, J. Wiley & Sons, Chichester.

Churchman, C.W. and R.L. Ackoff (1954): "An Approximate Measure of Value", Journal of the Operations Research Society of America, Vol.2, No.2, pp.172-178.

Churchman, C.W. (1979): The Systems Approach, (2nd edition), Dell Publishing Co., New York.

Cleland, D.I. and W.R. King (1983): Systems Analysis and Project Management (3rd edition), International Student Edition, McGraw-Hill International, Tokyo, Japan.

Cody, J., H. Hughes and D. Wall (1980): "Introduction", in J. Cody et al (ed). Policies for Industrial Progress in Developing Countries, Oxford University Press, Oxford.

Cockburn, P. (1978): "Development Plans Depend on More Local Skills", Middle East Economic Digest, Vol.21, No.39, p.5-21.

Cohon, J.L. (1978): Multiobjective Programming and Planning, Academic Press, New York.

Constable, J. (1984): "Managing the U.S.S.R.", Management Today, September.

Coombs, C.H. (1975): "Portfolio Theory and the Measure of Risk", in M.F. Kaplan & S. Schwartz (eds), Human Judgement and Decision Processes, Academic Press, New York.

Crozier, M. (1964): The Bureaucratic Phenomenon, Tavistock, London.

Cuenod, M.A. (1980): "System Analysis and Development - Possibilities and Limits", in N. Najim & M. Abdel Fatah (eds), System Approach for Development, IFAC, Rabat, Morocco, Pergamon Press, Oxford.

Cyert, R.M. and J.G. March (1963): A Behavioural Theory of the Firm, Prentice-Hall, N.J., U.S.A.

Dawes, R.M. (1964): "Social Selection based on Multi-dimensional Criteria", Journal of Abnormal and Social Psychology, Vol.68, No.1, pp.104-109.

De Neufville, R. and R.L. Keeney (1972): "Systems Evaluation through Decision Analysis: Mexico City Airport", Journal of Systems Engineering, Vol.3, No.1, pp.34-50.

Department of Employment (1974): Company Manpower Planning, Manpower Paper No.1, HMSO, London.

Dror, Y. (1964): "Muddling through - 'Science' of Inertia", Public Administration Review, Vol.24, pp.153-157.

Dror, Y. (1971): Design for Policy Sciences, Elsevier, New York.

Duckstein, L. et al (1975): "Interactive Multi-Objective Decision Making under Uncertainty", in D.J. White & K.C. Bowen (eds), The Role and Effectiveness of Theories of Decision in Practice, Hodder & Stroughton, London.

Dyer, J.S. and R.K. Sarin (1979): "Group Preference Aggregation Rules based on Strength of Preference", Management Science, Vol.25, pp.822-832.

Eden, C. et al (1983): Messing about in Problems, Pergamon Press, Oxford.

Edwards, J.S. (1983a): "A Survey of Manpower Planning Models and their Application", Journal of the Operational Research Society, Vol.34, No.11, pp.1031-1040.

Edwards, J.S. (1980b): "Models of Manpower Stocks and Flows", in J.S. Edwards et al (eds), Manpower Planning Strategy and Techniques in an Organisational Context, J. Wiley & Sons, Chichester.

Edwards, W. (1977): "Use of Multiattribute Utility Measurement for Social Decision Making", in D.E. Bell et al (eds), Conflicting Objectives in Decisions, J. Wiley & Sons, New York.

Einhorn, H.J. and R.M. Hogarth (1981): "Behavioural Decision Theory: Processes of Judgement and Choice", Annual Review of Psychology, Vol.32, pp.53-88.

Eldin, H.K. and I. Avots (1978): "Guidelines for Successful Management of Projects in the Middle East: the client point of view", Proceedings of the Project Management Institute, 10th Annual Symposium, Los Angeles, October, 8-11, 1978.

Eliasberg, J. and R.L. Winkler (1981): "Risk Sharing and Group Decision Making", Management Science, Vol.27, pp.1221-1235.

Encel, S. et al (1975): The Art of Anticipation - Values and Methods in Forecasting, Martin & Robertson, London.

Estrin, S and P. Holmes (1982): "What can the U.K. Learn from France's Ninth Plan?", Financial Guardian, The Guardian, 28th September.

Estrin, S. and P. Holmes (1983): French Planning in Theory and Practice, Allen & Unwin, London.

Ettelstein, M.S. (1970): "Integrating the Manpower Factor into Planning, Programming, Budgeting", Public Personnel Review, Vol.31, No.1, pp.51-54.

Etzioni, A. (1967): "Mixed Scanning: A Third Approach to Decision Making", Public Administration Review, Vol.27, pp.385-392.

Etzioni, A. (1968): The Active Society: A Theory of Societal and Political Processes, Collier-McMillan, London.

Faludi, A. (1973): Planning Theory, Pergamon Press, Oxford.

Farquhar, P.H. (1980): "Advances in Multi-Attribute Utility Theory", Theory and Decisions, Vol.12, pp.59-89.

Fisch, G.G. (1961): "Line-staff is Obsolete", Harvard Business Review, September.

Fishburn, P.C. (1965): "Independence in Utility Theory with Whole Product Sets", Operations Research, Vol.13, No.1, pp.28-45.

Fishburn, P.C. (1977): "Multi-Attribute Utilities in Expected Utility Theory", in D.E. Bell et al (eds), Conflicting Objectives in Decisions, J. Wiley & Sons, New York.

Fishburn, P.C. and R.C. Keeney (1974): "Seven Independence Concepts and Continuous Multi-Attribute Utility Functions", Journal of Mathematical Psychology, Vol.11, No.3, pp.294-372.

Flowerdew, et al (1972): "Choosing a Site for the Third London Airport", in R. Layard (ed), Cost Benefit Analysis, Penguin Books, Harmondsworth.

French, S. (1982): "A Survey and Interpretation of Multi-Attribute Utility Theory", in S. French et al (ed), Multi-Objective Decision Making, Academic Press, London.

French, S. (1983): "Interactive Multi-Objective Programming: Its Aims, Applications and Demands, Journal of the Operational Research Society, Vol.35, No.9, pp.827-834.

Friend, J.K. and W.N. Jessop (1976): Local Government and Strategic Choice (2nd edition), Pergamon Press, Oxford.

Gardiner, P.C. and W. Edwards (1975): "Public Values: Multi-Attribute Utility Measurement for Social Decision Making", in M.F. Kaplan and S. Schwartz (eds), Human Judgement and Decision Processes, Academic Press, New York.

Ginzburg, E. (1971): Manpower for Development, Praeger, New York.

Goicoechea, A. et al (1982): Multi-Objective Decision Analysis with Engineering and Business Application, J. Wiley & Sons, New York.

Goodman, L.J. and R.N. Love (1980): Project Planning and Management - An Integrated Approach, Pergamon Press, Oxford.

Grinold, R.C. and K.T. Marshall (1977): Manpower Planning Models, Elsevier North-Holland Inc., New York.

Gupta, S.K. and J.V. Rosenhead (1969): "Robustness in Sequential Investment Decisions", Management Science, Vol.15, pp.18-29.

Hannan, E.L. (1983): "An Eigen Value Method for Evaluating Contestants", Computing & Operations Research, Vol.10, No.1, pp.41-46.

Higgins, B. (1968): Economic Development (revised edition), W.W. Norton & Co. Inc., New York.

Hinloopen, E. et al (1982): "The Regime Method: A New Multiple Criteria Technique", in P. Hansen (ed), Essays and Surveys on MCDM, Springer, Berlin.

Holland, S. (1982): "Planning is No Longer a Dirty Word", The Guardian, 29th November.

Hope, R.F.A. (1973): "Some Statistical Aspects of Manpower Planning in the Civil Service", in D.J. Bartholomew (ed), Manpower Planning, Penguin Books, Harmondsworth.

Hughes, D.B. (1971): "Introduction", in D.J. Bartholomew (ed), Manpower Planning, 1976, Penguin Books, Harmondsworth.

Humphreys, P. and A. Humphreys (1975): "An Investigation of Subjective Preference Ordering for Multi Attribute Alternatives", in D. Wendt and C.A.J. Vlek (eds), Utility, Probability and Human Decision Making, Riedel, Dordrecht, The Netherlands.

Hunter, L.C. and C. Mulvey (1981): Economics of Wages and Labour (2nd edition), McMillan, London.

Hwang, C.L. and A.S.M. Masud (1979): Multiple Objective Decision Making: Methods and Application - A State-of-the-Art Survey, Springer-Verlag, New York.

Hwang, C.L. and K. Yoon (1981): Multiple Attribute Decision-Making: A State-of-the-Art Survey, Springer-Verlag, New York.

IMS - Institute of Manpower Studies (1982): Relating Manpower to an Organisation's Objectives - IMS Report No.56, R.C. Carpenter (ed), IMS, University of Sussex, Brighton.

Iraqi Official Gazette (1970): "Law 70 of 1970 - The Five Year National Development Plan 1970/1971 - 1974/1975" (in Arabic), Iraqi Official Gazette No.1862 of 1/4/1970, Ministry of Information, Baghdad, Iraq.

Iraqi Official Gazette (1977): "Law 89 of 1977 - The National Development Plan 1976-1980" (in Arabic), Iraqi Official Gazette, No. 2600 of 18/7/1977, Ministry of Information, Baghdad, Iraq.

Janis, I.L. and L. Mann (1977): Decision Making: A Psychological Analysis of Conflict, Choice and Commitment, The Free Press, New York.

Jenkins, G.M. (1969): "The Systems Approach", in J. Beishon and G. Peters (eds), Systems Behaviour (2nd edition), 1976, Harper & Row, London.

Johnstone, D.F. (1969): "The Integration of Supply and Demand Projection of Labour Force", in D.J. Bartholomew (ed), Manpower Planning, 1976, Penguin, Harmondsworth.

Kadhim, M. (1974): The Strategy of Development Planning and the Absorptive Capacity of the Economy - A Case Study of Iraq, Ph.D. Thesis, University of Colorado, U.M.I., Ann Arbor, MI, U.S.A., (microfiche).

Kahalas, H. and D.A. Gray (1976): "Model for Manpower Decision Making", OMEGA, Vol.4, No.6, pp.685-697.

Keeney, R.L. (1972): "An Illustrated Procedure for Assessing Multi-Attributed Utility Function", in G.M. Kaufman and H. Thomas (eds), Modern Decision Analysis, 1977, Penguin, Harmondsworth.

Keeney, R.L. (1979): "Evaluation of Proposed Storage Sites", Operations Research, Vol.27, No.1, pp.48-64.

Keeney, R.L. (1981): A Technology Choice Model for Electricity Generation, Woodward-Clyde Consultants, San Francisco, U.S.A.

Keeney, R.L. and C.W. Kirkwood (1975): "Group Decision Making using Cardinal Social Welfare Functions", Management Science, Vol.22, pp.430-437.

Keeney, R.L. and H. Raiffa (1976): Decisions with Multiple Objectives, J. Wiley & Sons, New York.

Kelleher, E.J. and K.L. Cotter (1982): "An Integrative Model for Human Resource Planning and Strategic Planning", Human Resource Planning, Vol.5, no.1, pp.15-27.

- Kenney, J. et al (1972): Manpower Training and Development, (2nd edition), Institute of Personnel Management, London.
- Kepner, C.H. and B.B. Tregoe (1981): The New Rational Manager, John Martin, London.
- Kindleberger, C.P. (1967): "French Planning", in M.F. Millikan (ed), National Economic Planning, Columbia University Press, New York.
- Lal, D. (1980): "Public Enterprises", in J. Cody et al (eds), Policy for Industrial Progress in Developing Countries, Oxford University Press, Oxford.
- Lawrence, J. (1973): "Manpower and Personnel Models in Britain", Personnel Review, Vol.2, No.3, pp.4-27.
- Layard, P.R.G. et al (1971): Qualified Manpower and Economic Performance, Penguin, Allen Lane, London.
- Lee, S.M. and E.R. Clayton (1972): "A Goal Programming Model for Academic Resource Allocation", Management Science, Vol.18, No.8, pp.B359-408.
- Liechester, C.S. (1971): "Future Manpower Requirements of the British Economy", in D.J. Bartholomew (ed), Manpower Planning, 1976, Penguin, Harmondsworth.
- Lindblom, C.E. (1959): "The Science of Muddling Through", Public Administration Review, Vol.19, pp.79-99.
- Lindblom, C.E. (1965): The Intelligence of Democracy, Free Press, New York.
- Little, M.D. and J.A. Mirlees (1979): Project Appraisal and Planning for Developing Countries (2nd edition), Hienemann Educational Books, London.
- Lock, D.L. (1968): Project Management, Gower Press Ltd, London.
- Loveridge, R. (1983): "Behavioural Approaches to Manpower Planning", in J.S. Edwards et al (ed), Manpower Planning - Study and Techniques in an Organizational Context, J. Wiley & Sons Ltd, Chichester.

Lovins, A.B. (1977): "Cost-Risk Benefit Assessments in Energy Policy", George Washington Law Review, Vol.45, No.5, pp.911-943.

Lusk, E.J. (1979): "Analysis of Hospital Capital Decision Alternatives: A Priority Assignment Model", Journal of the Operational Research Society, Vol.30, No.8, pp.439-448.

MacCrimmon, K.R. (1968): "Descriptive and Normative Implications of the Decision Theory Postulates", in K. Borch and J. Mossin, Risk and Uncertainty, St. Martin's, New York.

MacCrimmon, K.R. (1973): "An Overview of Multiple Objective Decision Making", in M. Zeleny and J.L. Cochrane (eds), Multiple Criteria Decision Making, University of South Carolina Press, S.C., U.S.A.

MacCrimmon, K.R. and R.N. Taylor (1975): "Decision Making and Problem Solving", in M.D. Dunette (ed), Handbook of Industrial and Organizational Psychology, Rand-McNally, Illinois, U.S.A.

MacCrimmon, K.R. and J.K. Sui (1974): "Making Trade-Offs", Decision Science, Vol.5, pp.680-704.

Mangan, J. and M. Silver (1983): "Forecasting the Demand for Labour Using Labour Productivity Trends", in J.S. Edwards et al (eds), Manpower Planning - Strategy and Techniques in an Organizational Context, J. Wiley & Sons, Chichester.

Mannheim, K. (1966): Ideology and Utopia - An Introduction to the Sociology of Knowledge, Routledge & Kegan Paul, London.

March, J.G. and H.A. Simon (1958): Organisations, J. Wiley & Sons, New York.

Marzuk, M.S. (1981): "An Econometric Input-Output Approach for Projecting Manpower Requiriements. The Case of Kuwait", in N.A. Sherbiny (ed), Manpower Planning in the Oil Countries, JAI Press Inc., Greenwich, Conn., U.S.A.

Masud, A.S. and C.L. Hwang (1981): "Interactive Sequential Goal Programming", Journal of the Operational Research Society, Vol.32, No.5, pp.391-400.

Mathur, A. (1971): "Balanced V's Unbalanced Growth - A Reconciliatory View", in A.B. Mountjoy (ed), Developing the Underdeveloped Countries, J. Wiley & Sons, New York.

Meddings, J.I.J. (1979): A Stochastic Model for Manpower Planning, Doctoral Thesis, University of Aston, Birmingham, U.K.

Miller, G.A. (1956): "The Magical Number Seven, Plus or Minus Two", Psychological Review, Vol.63, pp.81-97.

Ministry of Planning (1974): The Final Report of the Committee to Study the Requirements of the National Development Plan for Various Specialisation for the Years 1975-1980 (in Arabic), Ministry of Planning, Baghdad, Iraq.

Ministry of Planning (1978a): The National Development Plan, 1970-1974, (in Arabic), Ministry of Planning, Baghdad, Iraq.

Ministry of Planning (1978b): Census 1977, (in Arabic), Ministry of Planning, Baghdad, Iraq.

Ministry of Planning (1980): Annual Abstract of Statistics (1980), Ministry of Planning, Baghdad, Iraq.

Ministry of Planning (1982): Statistical Pocket Book - 1982, Ministry of Planning, Baghdad, Iraq.

Ministry of Planning (1983): Gross Indicators and Structural Variation for the Period 1976-1980 (in Arabic), Ministry of Planning, Baghdad, Iraq.

Ministry of Planning (1984): Planning and Development: Indicators and Figures (in Arabic), Ministry of Planning, Baghdad, Iraq.

Mishan, E.J. (1976): Cost Benefit Analysis, Praeger, New York.

Moskowitz, H. and G.P. Wright (1979): Operations Research Techniques for Management, Prentice-Hall Inc., N.J., U.S.A.

Myrdal, G. (1964): Beyond the Welfare State, Yale University Press, New Haven, U.S.A.

Myrdal, G. (1968): Asian Drama - An Inquiry into the Poverty of Nations, Penguin Books, Harmondsworth.

Odell, P.R. (1981): Oil and World Power (6th edition), Penguin Books, Harmondsworth.

Oil & Development (1977): "Introduction" (in Arabic), Oil & Development Journal, 3rd year, June, Ministry of Information, Baghdad, Iraq.

Pettigrew, A.M. (1973): The Politics of Organizational Decision-Making, Tavistock, London.

Porter, A.L. et al (1980): A Guide Book for Technology Assessment and Impact Analysis, Elsevier North Holland, New York.

Price, W.L. et al (1980): "A Review of Mathematical Models in Human Resource Planning", OMEGA, Vol.8, No.6, pp.639-645.

Purkiss, C. (1981): Forecasting the Size of Labour Forces - IMS Report No.6, IMS, University of Sussex, Brighton.

Rosenhead, J.V., M. Elton and S.K. Gupta (1972): "Robustness and Optimality as Criteria for Strategic Decisions", Operational Research Quarterly, Vol.23, pp.413-431.

Rosenhead, J.V. (1978): "An Education in Robustness", Journal of the Operational Research Society, Vol.29, pp.105-111.

Rosenhead, J.V. (1980a): "Planning Under Uncertainty: I. The Inflexibility of Methodologies", Journal of the Operational Research Society, Vol.31, pp.209-216.

Rosenhead, J.V. (1980b): "Planning Under Uncertainty: II. A Methodology for Robustness Analysis", Journal of the Operational Research Society, Vol.31, pp.331-341.

- Saaty, T.L. (1977a): "A Scaling Method for Priorities in Hierarchical Structures", Journal of Mathematical Psychology, Vol.15, No.3, pp.234-281.
- Saaty, T.L. (1977b): "The Sudan Transport Study", Interfaces, Vol.8, No.1 (part 2).
- Saaty, T.L. (1980): The Analytical Hierarchy Process, McGraw-Hill, New York.
- Sabie, A. (1980): Industrial Manpower Needs in Iraq with Implication for Industrial Education, Ph.D. Thesis, University of Missouri - Columbia, UMI, Ann Arbor, MI, USA, Ref. 80-24392 (microfiche).
- Sagasti, F.R. (1972): "Management Sciences in an Underdeveloped Country", Management Sciences, Vol.19, pp.121-131.
- Sagasti, F.R. (1976): "Thoughts on the Use (and Abuse) of OR/MS in the Planning and Management of Development", Operational Research Quarterly, Vol.27, pp.937-947.
- Sage, A.P. (1977): A Methodology for Large Scale Systems, McGraw-Hill, New York.
- Sassone, P.G. and W.A. Schaffer (1978): Cost-Benefit Analysis: A Handbook, Academic Press, New York.
- Schwenk, C. and H. Thomas (1983): "Formulating the Mess - the Role of Decision Aids in Problem Formulation", OMEGA, Vol.11, No.3, pp.239-252.
- Scitovsky, T. (1954): "Two Concepts of External Economics", Journal of Political Economy, Vol.62, pp.143-151.
- Sears, D. (1973): "What are we Trying to Measure", Development Digest, U.S.A., State Department, Vol.11, No.2.
- Serageldin, M.I. (1981a): "The Modelling and Methodology of Manpower Planning in the Arab Countries", in N.A. Sherbiny (ed), Manpower in the Oil Countries, JAI Press, Greenwich, Conn., U.S.A.

Serageldin, M.I. (1981b): "Labour Adaption in the Oil Exporting Countries", in N.A. Sherbiny (ed), Manpower Planning in the Oil Countries, JAI Press, Greenwich, Conn., U.S.A.

Shapley, L.S. and M. Shubik (1954): "A Method for Evaluating the Distribution of Power in a Committee System", The American Political Science Review, Vol.48, No.3, pp.787-792.

Shepard, R.N. (1964): "On Subjectively Optimum Selections among Multi-Attribute Alternatives", in M.W. Shelley and G.L. Bryen (eds), Human Judgements and Optimality, J. Wiley & Sons, New York.

Sherbiny, N.A. (1981): "Labour and Capital Flows in the Arab World: A Policy Perspective", in N.A. Sherbiny (ed), Manpower Planning in the Oil Countries, JAI Press, Greenwich, Conn., U.S.A.

Sheridan, J.E. et al (1975): "Comparative Analysis of Expectancy and Heuristic Models of Decision Behaviour", Journal of Applied Psychology, Vol.60, pp.361-368.

Silver, M. (1983): "Forecasting the Demand for Labour using Labour Productivity Trends", in J.S. Edwards et al (ed), Manpower Planning - Strategy and Techniques in an Organisational Context, J. Wiley & Sons, Chichester.

Sinuanay-Stern, Z. (1984): "A Network Optimization Model for Budget Allocation in a Multi-Campus University", Journal of the Operational Research Society, Vol.35, No.8, pp.749-757.

Slovic, P. et al (1977): "Behavioural Decision Theory", Annual Review of Psychology, Vol.28, pp.1-39.

Slovic, P and S.C. Lichtenstein (1971): "Comparison of Bayesian and Regression Approaches to the Study of Information Processing in Judgement", Organizational Behavior and Human Performance, Vol.11, pp.172-194.

Slovic, P. and D.J. Macphillamy (1974): "Dimensional Commensurability and Cue Utilization in Comparative Judgement", Organizational Behavior and Human Performance, Vol.11, pp.72-94.

- Smith, A.R. (1971): "Some Views on Manpower Planning", in D.J. Bartholomew (ed), Manpower Planning, Penguin Books, Harmondsworth.
- Sodberg, P. (1963): "The Structure of Individual Goals", in The Psychology of Management Decision, J. Wiley & Sons, New York.
- Stainer, G. (1971): Manpower Planning, Heinmann Educational Books, London.
- Starr, M.K. (1966): "Planning Models", Management Science, Vol.13, No.4.
- Stern, G.A. (1976): "SOSIP-ing: Sophisticated Obfuscation of Self Interest and Prejudice", Operational Research Quarterly, Vol.27, No.4, pp.915-929.
- Svenson, O. (1979): "Process Description of Decision Making", Organizational Behavior and Human Performance, Vol.23, pp.86-112.
- Taylor, B.W. et al (1983): "An Integer Goal Programming Model for Determining Military Aircraft Expenditure", Journal of the Operational Research Society, Vol.34, No.5, pp.379-390.
- Tell, B. (1977): "An Approach to Solve Multi-Person Multi-Criteria Decision-Making Problems", in Multiple Criteria Problem-Solving: Proceedings, Buffalo, N.Y., U.S.A., 1977, Springer-Verlag, New York.
- Terry, H. (1963): "Comparative Evaluation of Performance using Multiple Criteria", Management Science, Vol.9, No.3, pp.431-442.
- Tinbergen, J. (1967): Development Planning, World University Library, Weidenfeld and Nicholson, London.
- Tversky, A. (1969): "Intransitivity of Preferences", Psychological Review, Vol.76, pp.31-48.
- Tversky, A. (1972a): "Choice by Elimination", Journal of Mathematical Psychology, Vol.9, pp.341-367.
- Tversky, A. (1972b): "Elimination by Aspects: A Theory of Choice", Psychological Review, Vol.79, pp.281-299.

Tversky, A. and D. Kahneman (1974): "Judgement Under Uncertainty: Heuristics and Biases", in G.M. Kaufman and H. Thomas (eds), Modern Decision Analysis, 1977, Penguin, Harmondsworth.

Tversky, A. and D. Kahenman (1975): On the Elicitation of Preferences: Descriptive and Prescriptive Considerations. Paper presented at Workshop on Decision Making with Multiple Conflicting Objectives, IIASA, Laxenburg, Austria.

U.N.I.D.O. (1975): The Initiation and Implementation of Industrial Projects in Developing Countries: A Systematic Approach, United Nations, New York.

Walker, J.W. (1978): "Linking Human Resource Planning and Strategic Planning", Human Resource Planning, Vol.1, No.1, pp.1-18.

Walter, B. (1966): "Internal Central Relations in Administrative Hierarchies", Administrative Science Quarterly, Vol.11, No.2, pp.179-206.

Wind, Y. and T.L. Saaty (1980): "Marketing Application of the Analytical Hierarchy Process", Management Science, Vol.26, No.7, pp.641-658.

Wolstenholme, E.F. and R.G. Coyle (1983): "The Development of System Dynamics as a Methodology for System Description and Qualitative Analysis", Journal of the Operational Research Society, Vol.34, No.7, pp.569-582.

Wright, P. (1974): "The Harrassed Decision Maker: Time Pressure, Distractions and the Use of Evidence", Journal of Applied Psychology, Vol.59, pp.555-561.

Zeleny, M. (1974): Linear Multi Objective Programming, Springer-Verlag, New York.

Zeleny, M. (1980): "Foreword", Computers and Operations Research, Vol.7, pp.1-4.

Zeleny, M. and J.L. Cochrane (1973): "A Priori and a Posteriori Goals in Macro-Economic Policy Making", in M. Zeleny and J.L. Cochrane (eds), Multiple Criteria Decision Making, University of South Caroline Press, South Carolina, U.S.A.

Zwicky, F. (1969): Discovery, Invention, Research: Through the Morphological Approach, McMillan, Toronto, Canada.