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An Improved Problem Solving and Decision Making Process for the Modern Thai Organization

Watana Patanapongse[*]

1. Introduction

All managers must be good decision makers (Rue and Byars, 1995: 54). Herbert Simon divides decision making into three stages: (1) intelligence, (2) design, and (3) choice (Simon, 1960: 2). Intelligence is searching the environment for conditions that require a decision. At the second stage possible courses of action are developed and analysed. Finally, one must be chosen. Management decisions depend much on the intelligence and design stages. Some situations requiring a decision occur repeatedly. Such "programmed" decisions can be reduced to the application of standardized rules and delegated to subordinates. Of much greater interest are "non-programmed" decisions. Decisions that affect the future prosperity of the organization are to an extent unique, unprecedented. They involve risk, uncertainty. It may not indeed be clear just what are the problems to be solved, and the outcomes of the various alternatives available is unpredictable. These decisions call for all the skills of expert management.

It is to programmable decisions that the so-called **Classical Model** of decision making is most applicable. It is hardly applicable to non-programmable decision situations (Simon, 1960: 5-6; Etzioni, 1989: 122-126). For these complex, unpredictable situations Simon developed his **Administrative Model** (March and Simon, 1958; Simon, 1957a: 196-205; Simon, 1957b.)

There is some confusion between "decision making" and "problem solving." Problem solving involves decision making; but many decisions are not concerned with problems. Nonetheless, managerial decisions are usually concerned with solving or circumventing problems.

[*] Research Center, National Institute of Development Administration

Albert Einstein once said "The significant problems we face cannot be solved at the same level of thinking we were at when we created them." He was talking about paradigms. Our problems are the product of our present paradigms and cannot be solved without breaking out of these paradigms. The word "paradigm" means a model or frame of reference. It is the way we "see" the world. A paradigm is a mental model.

Stephen Covey (1991) suggests that the key to problem solving is to examine your paradigms to see if they are really accurate, to see if they reflect correctly the territory you are in. Present problems are a product of existing paradigms; and major problems cannot be solved by working harder within these paradigms. The real problem which exists in the field of management today is one of operating within an obsolete paradigm: one that is not necessarily totally wrong, but is incomplete. To try to solve a problem by a partial, obsolete, or wrong paradigm may reach a partial objective, a certain purpose, or may just miss the target.

At the start of any problem solving or decision making activity, the manager must keep in mind the following two considerations: (1) Are we in the right paradigm? (2) If we are in the right paradigm, do we have any accepted or recognised model for the task? Management wants the right decision made or the least cost spent on the decision making process. This needs an effective and efficient decision making model.

Our objectives then are:

(1) To develop an understanding of the theories on and processes for improving the quality and efficiency of problem solving and decision making as needed for the modern Thai organization, and of how this understanding can, and will in the future, shape a better organization with more efficient management.

(2) To achieve an enhanced awareness of positive developments in the processes of problem solving and decision making within the modern Thai computerized organization, and a knowledge base form which to deal more effectively with these changes.

Meaning or definition of a problem

Kepner and Tregoe (1965) define a problem as an unanticipated change which produces an unwanted effect. Francis (1990) classifies different types of problem as: (1) Mystery - an unexplained deviation with an unknown cause. (2) Assignment - when an individual is given a task to do by someone else. (3) Difficulty - due to lack of awareness of how to manage the situation or lack of resources. (4) Opportunity - a situation which offers a potential benefit. (5) Puzzle - which has a correct answer, to find which complexities and uncertainties must be unravelled. (6) Dilemma - there are at least two options for action which are equally attractive or unattractive.

According to Cortada and Woods (1995), a problem is a consequence of not conforming to a quality standard. The defect or error needs to be resolved. In quality management, a primary assumption is that problems derive from the way a process operates, not from people implementing a process. Instead of trying to identify who caused a problem, the manager looks at what aspects of the process caused it. Quality tools and techniques help us measure, understand, and fix the problems that occur in processes.

Common Mistakes in Problem Definition

(1) Defining the problem too broadly or too narrowly. The problem stated as "Build a better mousetrap" might be better defined as "Get rid of the mice." The latter approach opens the situation to a much wider range of problem solving options than the former. One reason why problems are sometimes misdefined is selective perception. In a business setting, it is likely that marketing, production, and finance specialists will define a problem in a way consistent with their areas of expertise. Each point of view may be too narrow. In a poorly managed task force, they may cause disruptive conflict; in a well managed one, different points of view can greatly benefit problem solving.

(2) Focusing on Symptoms Instead of Causes. Symptoms alert managers to the presence of problems, but they should not be mistaken for the problems themselves or for their causes. Absenteeism, turnover, tardiness, negative attitudes, poor quality work, and declining work quantity, are typically

problem symptoms. The underlying reasons for their occurrence are the problem causes. Good solutions eliminate the causes of problems and do not just treat the symptoms. Informed managers understand this distinction.

(3) Choosing the Wrong Problem. Managers must set priorities and deal with the most important problems first, giving priority to problems that are truly solvable, given a realistic investment of time and other resources. Good managerial judgement in selecting which problems to address, in what order of priority, and how, is essential. Problem solving proceeds with the generation and evaluation of alternative solutions, for which information is needed. Common mistakes are being too quick in selecting a particular solution for implementation, choosing a convenient alternative that has damaging side effects, will not work fast enough, or is not as good as others that might have been discovered with a little extra effort.

2. An Efficient Process for Problem Solving

A manager makes decisions in order to solve problems (Janis, 1989: 143; Smith, 1989). Organizational problems range over a continuum from crisis problems, requiring urgent attention, through non-crisis problems, to opportunities that do not demand immediate attention, but may be lost if managers try to put them off indefinitely.

1. Crisis problems. Here managers face a critical situation, and a decision must be reached as quickly as possible (Kuklan,1988).

2. Non-crisis problems. These are situations without the urgency of a crisis problem. Most managerial problems are of this type.

3. Opportunity problems. Here the organization may gain some significant advantage (Janis,1989: 143). The manager's job is to make a creative breakthrough (Mintzberg, Raisinghani and Theoret, 1976; Nutt, 1989b). If an opportunity problem is ignored a crisis problem may easily ensue. At the same time, a crisis problem may be turned into an opportunity problem by a creative manager who sees it as an opportunity to innovate.

Problems may also be classified as routine or nonroutine:

1. **Routine problems** arise on a regular basis and can be addressed through standard responses. Called programmed decisions, an increasing number are being handled by computers using decision support software.

2. **Nonroutine problems** have not been encountered before, they require solutions that are specifically tailored to the situation, and the information requirements are high. Though computer support may assist, the decision will be made largely on the basis of human judgement. The majority of problems faced by higher-level managers are of this type.

Thirdly, we may classify problems as expected and unexpected:

1. **Expected problems** are situations for which the manager can plan ahead or even prevent their occurrence. Knowing that problems may occur, extra care can be used when making the decisions and plans can be made to handle any such problems that may arise.

2. **Unexpected problems** are addressed by reaction after their occurrence. Astute and "proactive" managers - ones we may call problem-seekers - are, through foresight, able to turn unexpected problems into expected ones.

It is to "ill-structured" problems, unprogrammable decisions, that we must turn, when considering efficiency in problem solving. In the business world it is uncertainty that is the problem for the problem solver, incompleteness of information, unpredictability. The less the information, the greater the risk. Yet decisions must be decisive. The cause is identified. Alternative solutions are generated, evaluated and their consequences considered; a solution is chosen, implemented and the results evaluated. It is the stage of development of alternative solutions that most calls for creativity - and there have been detailed studies on how to enhance creativity.

In the modern world it is fast moving firms that achieve competitive advantage. These firms involve personnel effectively and creatively in the decision making process, they develop many alternatives simultaneously; and they rely, not so much on long term planning as on real-time, current information - these firms above all know the meaning of information.

3. Problem Cause Analysis

Causal analysis concentrates on (1) identifying specific failures or defects, (2) discovering root causes of these failures, and (3) eliminating these defects by implementing solutions that address the appropriate cause (Cortada and Woods, 1995: 55; Saylor, 1992; Miller and Krumm, 1992).

Successful problem solving involves the careful identification of causes of problems. However, the causative factors underlying a problem are often complex. Lyles (1982: 11-13) distinguishes three levels on which analysis can be conducted:

1. **Causal level events**. The primary event that triggers off a chain of further events leading to the undesired outcome.
2. **Intervening variables**. These are events, conditions or phenomena which occur at intermediate stages in the chain reaction and modify the final outcome.
3. **Output level**. These are the conditions at the final stage. analysis at this level is results analysis.

Lyles gives as an example the breakdown of the Three Mile Island nuclear reactor. In this case the primary cause was a valve failure, leading to malfunction of the coolant system. The intervening variable was inadequate training of the operators, who failed to act promptly to check the malfunction before control was lost. The end result was meltdown of the reactor and, considering the difficulty of cleaning the radioactive interior, probably permanent shutdown.

Long term improvement is unlikely unless the primary cause of the problem is discovered. Causes are classified, in the cause-and-effect analysis of Ishikawa (Cortada and Woods, 1995, pp. 56-58), as to whether they fall in one or other of five major categories, the 5 Ms: (1) machinery (equipment), (2) methods (processes), (3) manpower (human resources), (4) measurements, and (5) materials. Once the problem is identified, one considers each of these categories.

Lyles classifies problems into three categories:

1. **People** - caused by the behaviour of individuals or groups of personnel.

2. **Operational** - caused by factors of policy, organizational structure, finance and the economy, market conditions and marketing, laws and regulations, operations, communications and public relations, planning and evaluation.

3. **Technical** - caused by inadequate functioning or failure of machinery and equipment.

Lyles' category of "people" corresponds to "manpower" among the 5Ms, "technical" to "machinery"; but "operational" is a broad category, that includes factors outside the organization.

4. Models of Problem Solving

Einstein's Model of Problem Solving

As mentioned previously, Einstein once said that "The significant problems we face cannot be solved at the same level of thinking we were at when we created them." What the saying seems strongly to suggest is that, if a problem appears insolvable, we must change our paradigm. We have to start thinking about the problem in a wholly new way. Perhaps the problem seems difficult because the assumptions we have been making are incorrect.

Einstein's own work illustrates the point. Newtonian physics had remained unquestioned for 300 years because it works perfectly well in everyday life. At the beginning of the 20th century certain experiments had been made which gave results that could not be explained by the Newtonian paradigm - in particular an experiment that seemed to show that the velocity of light is independent of the motion of the observer making the measurement. Ingenious, but unconvincing, attempts were made to explain these results while holding on to the assumptions of Newtonian physics. Einstein showed that the results could be explained by dropping the assumptions of Newtonian physics. Instead, adopt the assumption that what the experiment is telling you is literally true: The velocity of light in space is the same anywhere, irrespective of the motion of the observer measuring it - and work out what the geometry of space and time must be to accord with this assumption.

The consequences that Einstein could deduce from this new paradigm were quite startling, including that matter and energy were equivalent and in principle interconvertible, a fact that led Einstein, during World War II, to warn the US Government of the possibility of making an atomic bomb.

The message is that, when you meet a problem that presents a new and unexplainable situation, you must try a completely new way of thinking about it. You can afford to be confident that the problem, somewhere, has a solution. Einstein was committed to the belief that the Universe, however strange, was ultimately comprehensible - what the apparently anomalous experiments were saying was that it had to be looked at from a new point of view. You might begin by asking: what is the problem trying to tell you?

A General Model of Problem Solving

Lambert (1996, pp. 124-127) suggests the following as a simple and common model for problem solving.

1. A problem must be seen to exist.

Before any action is taken, someone must perceive that an undesirable situation exists - or at least, a situation exists in which there is room for improvement. Furthermore, it is assumed that there must be a way, if it can be found, of solving the problem: of creating the desired, or improved, situation.

What is perceived as a problem by one person may not be perceived - or may not consciously be perceived - as a problem by another. This is particularly brought out in the case of "people" problems, where someone may have a stake in **not** solving a problem. Such an individual, when presented with the problem by the problem owner (as defined below), is likely to react first by evasiveness: to deny that the problem exists.

It is only when a problem is perceived to exist that a solution will be sought.

2. A problem has an "owner."

The owner is the person who perceives the problem to exist and who requires a solution. Ownership is necessary to problem definition and effective implementation of a solution. The owner assumes responsibility for the outcome of the problem solving effort.

3. The type of problem determines the most suitable problem solving technique.

Where something in a production process has gone wrong, or where small improvements in quality are sought, the approach is likely to be "rational," deductive, seeking an identifiable cause of the problem and rectifying it, an approach that has been systematized by Kepner and Tregoe (1981). Problems of this type require no great creative effort.

Where the problem is that of the development of an entirely new product or process, or where complex environmental and personal situations are involved, innovative, creative and "lateral" thinking is required. The problem calls for new ideas. The techniques of "idea generation" which have been proposed and developed are quite numerous. Brainstorming and synectics are among the most well known.

4. Problems must be prioritized

Generally, crisis problems must be dealt with before noncrisis problems. However, opportunity problems should not be delayed. These are problems that require innovative and creative solutions.

5. Problem analysis.

In the case of problems requiring the "rational" approach, Lambert suggests that the following questions will need to be answered:

- What is happening?
- When is it happening?
- Where does it happen?
- Who is involved or affected?
- Which items or processes are involved?
- Why does it happen?

6. Possibilities and their evaluation.

The statement that all problems have causes is more useful in the case, for instance, of a production process breaking down. In such a case there is a cause or causes, which can be identified and remedied. In the case of opportunity problems, the driving force is rather one of motivation, for example, to take

advantage of a new market opening. In either case, solutions will need to be considered in terms of costs and benefits, innovativeness, feasibility and attractiveness to the problem owner.

7. Selection of preferred solution.

More than one possible solution or strategy is likely to be proposed. The solution to be implemented must be selected, usually with regard to maximum expectation of success with minimum cost.

8. Test and implementation.

The chosen solution is implemented and the outcome evaluated. The results will provide feedback which may well be the beginning of a fresh round of problem solving and implementation. Under the drive for total quality, all processes are subject to assessment and continuous improvement.

The Rational Model of Problem Solving

This model, as developed by Kepner and Tregoe (1965) takes the standpoint that information is the raw material of management. The manager uses information at the three stages of (1) identifying the problem, (2) analysis to find the cause and (3) decision making to adopt a solution.

No problem can be effectively solved until the cause is identified. Problem analysis is the process of using information to find the cause. These authors distinguish 14 steps in the process of problem analysis and solution:

1. Seven basic concepts of problem analysis:

1.1 The problem analyser has an expected standard of performance, a "should" against which to compare actual performance.

The manager recognizes problem areas by surveying the situation within his responsibility, comparing what is actually going on with what he believes should be going on.

1.2 A problem is a deviation from a standard of performance.

Usually the manager will find several problem areas, and must select one on the basis of urgency, seriousness and potential for growth.

1.3 A deviation from standard must be precisely identified, located and described.

The problem analyser must specify precisely: (1) What is going wrong? (2) Where does it happen? (3) When does it happen? and (4) How big is it? It is equally important to draw a boundary round the problem: Where does the problem not occur?

1.4 There is always something distinguishing that which has been affected by the cause from that which has not.

The manager compares the characteristics of what has, and what has not, been affected by the problem.

1.5 The cause of a problem is always a change that has taken place in some distinctive feature, mechanism, or condition to produce a new, unwanted effect.

To find relevant changes, the manager looks closely at each distinction he identifies in his specification of the problem.

1.6 The possible causes of a deviation are deduced from the relevant changes found in analysing the problem.

Such deductions enable the problem analyzing manager to establish a testable statement or proposition as to the possible causes of a problem.

1.7 The most likely cause of a deviation is one that exactly explains all the facts in the specification of the problem.

If the manager has systematically identified and verified the cause of a problem, he will be in a position to make sure that the action he decides on will actually take care of the problem, temporarily or permanently.

5. An Effective Decision Making Process

Managers make decisions daily on problems that differ widely. Many are repetitive, occur frequently, and require little thought. Others are less frequent and far from routine - some may occur only once in a manager's career. This is our classification into "programmed" and "non-programmed" decisions (Kast and Rosenzweig, 1985: 424-425).

1. Programmed Decisions. These amount merely to the application of predetermined rules (Chung, Lang and Shaw, 1989; Keen and Morton, 1978: 67-68, 85-86; Gillian, 1990).

2. Non-programmed Decisions. A unique, infrequent or unstructured situation cannot be handled by standardized decision rules. Such decisions are less clear-cut, have few precedents, and guidelines have not been developed for handling them routinely (Minzberg, Raisinghani and Theoret, 1976: 246-275; Keen and Morton, 1978: 67-68, 85-86; Holden, 1991).

If enough is known about the circumstances of a problem, a manager can make a decision with confidence in the outcome. In practice however, there is often insufficient information available to feel sure of the outcome of a decision. We may distinguish four situations: certainty, risk, uncertainty and ambiguity.

Certainty exists when the manager has not only sufficient information to understand the problem, but all possible outcomes, and their possible consequences, are known. In fact, there are few decision situations where it is possible to realistically predict the future with accuracy (Kast and Rosenzweig, 1985: 429; Moody, 1983: 4-5, 44; Hammonds, 1991).

Risk exists when, while there is sufficient information to understand the problem and alternative solutions, only an estimate of the probable outcomes of each alternative can be made (Fagley and Miller, 1987). For any decision, there is a chance that the consequences will not be what is intended. Managers put in much work trying to estimate risks and to improve the probability of success (Hill et al., 1979: 14; MacCrimmon and Wehrung, 1986: 9-10; March and Shapira, 1987). Risk may be assessed on the basis of past experience, as in Monsanto's estimate of the probability that its herbicide business will be hurt by bad weather conditions in any one year (Monsanto 1990 Annual Report).

Uncertainty exists when the problem is understood, but the possible alternative decisions are unclear. There is insufficient information to estimate even the probable outcomes of a decision. In fact, most managerial decisions made in the face of unpredictable environmental changes, involve uncertainty (Frederickson, 1984; Nutt, 1989a; MacCrimmon and Wehrung, 1986: 14-15; Verespej, 1990).

Ambiguity, the most challenging situation of all, exists when, not only is there little or no information on the alternatives and their consequences, but the nature of the problem itself is unclear. Even the goals to be achieved may be uncertain (Fanat and Ferris, 1990; Nutt, 1989a: 6-7; McClory, 1989).

6. Models of Managerial Decision Making

6.1 The Classical Model. The classical model makes a number of rather simplistic assumptions about the manager's approach to decision making. The manager's decision is "rational" and "objective." It is always in the best interest of the firm - which at the time the model was proposed meant that which brings in the optimum economic return. The manager has complete information on the problem, goals, alternative courses of action and their consequences, and logically weighs each alternative before coming to a decision. Obviously, such conditions are rarely realised in practice. The classical model is a prescriptive model: stating what managers might do under ideal conditions, and to which they might approach. Means do indeed exist to help managers make decisions in a more rational manner (Bazerman, 1990: 4-5).

6.2 The Administrative Model. The impossibility, in most instances, of realizing the classical model, led Simon to put forward a descriptive model: a model of how managers actually do make decisions in real life. In the first place, decisions are not always logical, rational or objective (Simon, 1957b; Janis, 1989: 28-31). Secondly, there is often only limited information available on the problem, alternatives and possible consequences; and, even when more is available, there is a limit to human and individual capacity to comprehend and handle information within the limited time often allowed for a decision. A manager can at best only endeavour to make the most rational decision possible within these limitations - the concept of what Simon called **bounded rationality**.

In practice, managers often do not go even this far. Rather than weighing every possible alternative available, even under the limits of bounded rationality, managers will resort to **satisficing**: Pressed for time, they will adopt the first alternative that meets at least the minimum requirements for a solution to the problem.

Both decision making models can be of service to the manager. The classical model urges the manager to make decisions more objectively and systematically. The administrative model explains how decision making processes must be adapted to the problem at hand (Bazerman, 1990: 4-5; Paquette and Kida, 1988).

Although the classical decision making model is prescriptive and the administrative descriptive, both offer valuable guidance for managers. In attempting to apply the classical model, managers can approach decisions more objectively and systematically. At times, managers are confronted with decisions in such numbers and in such rapid succession that they cannot effectively apply the classical model. The administrative model helps managers understand where their decision making deviated from the rational process prescribed by the classical model. Moreover, contemporary researchers recognize that managers actually adapt their decision making methods to the problem at hand. In this way, managers gain the flexibility and responsiveness to resolve problems that range from the simple to the highly complex (Bazerman, 1990: 4-5; Paquette and Kida, 1988).

The rational decision making process according to the classical model encompasses six sequential steps. That is: (1) Identify the problem, (2) Generate alternatives, (3) Evaluate alternatives, (4) Make the decision, (5) Implement the decision, and (6) Evaluate the results and provide feedback.

In real situations, the decision making process does not go so smoothly. Regardless of the type of problem, managers are often confronted by barriers that work against a rational decision. These barriers include (1) imperfect or incomplete information, (2) inaccurate identification of problems or alternatives, (3) biases, and (4) overcommitment or undercommitment.

For more effective decision making, it is suggested that behavioral tools may be applied. Considering the barriers, how can managers make better decisions? Experts suggest a number of ways to improve decision making: (1) Know when a decision is necessary, (2) Recognize constraints, (3) Develop critical thinking skills, (4) Apply experience and expertise, and (5) Use intuition.

Kepner and Tregoe (1965) prescribe seven basic concepts of decision making:

1. The objectives of a decision must be established first. What is the manager trying to accomplish? What is the job to be done?

2. The objectives are classified as to importance. At least one objective is a "must": a requirement that must be met. In addition there are "wants": for instance low cost and simple maintenance, which may conflict and must be weighed against each other.

3. Alternative actions are developed. Many alternative solutions may be available, of which some may be more economical or superior to others.

4. The alternatives are evaluated against the established objectives. Any alternative has to satisfy the "musts" of the problem. The decision will aim to optimize the "wants."

5. The choice of the alternative best able to achieve all the objectives represents the tentative decision. The best alternative meets all the "must" requirements and gives most of the "wants" with the fewest disadvantages. It is the action that, on balance, does the total job best. The choice may call for a combination of alternatives.

6. The tentative decision is explored for future possible adverse consequences. An adverse consequence is a new problem that may arise from the action taken. They must be assessed as to seriousness and probability. If the risks are too great, another decision may be necessary.

7. The effects of the final decision are controlled by taking other actions to prevent possible adverse consequences from becoming problems, and by making sure the actions decided on are being carried out.

Apart from the use of behavioral tools for effective decision making, managers can use a variety of quantitative tools to support the decision making process. These decision tools are especially valuable when planning production, analyzing inventory levels, and considering major budget expenditures. In general, quantitative tools help managers examine alternatives more comprehensively; they also help managers estimate the risks and reduce the uncertainty inherent in the situation. However, quantitative decision aids do not eliminate the need for managerial judgement. At best, they only clarify the alternatives, the consequences, and the probability of achieving the expected result so that managers can make a more informed decision (Forgionne, 1983; Wagner, 1988; Kast and Rosenzweig,

1985: 444). Among the most frequently used tools are: (1) the payoff matrix, (2) the decision tree, and (3) the simulation model.

(1) Payoff Matrix

The payoff matrix is a means for comparing the probable outcomes of two or more alternatives, under various future conditions (Hill et al., 1979: 120, 127). The possible alternatives are identified and plotted in a matrix against possible future conditions. The probability that each future condition, or "state of nature," will occur is next estimated. These must sum to unity, i.e. it is assumed that all possible futures have been identified. The value of each alternative's outcome, its "payoff," for each future condition, is calculated and multiplied by the probability of that future condition and the results summed to obtain the expected value of that alternative. The alternative with the highest expected value would appear to be the most favourable - assuming the initial estimates, especially of future probabilities, are reliable.

(2) Decision Tree

A decision tree is a graphical method of portraying the kind of information contained in a payoff matrix. The branches of the tree represent alternative courses of action, leading to further branch points depicting possible future states of nature with their probabilities and payoffs (Olson and Picconi, 1983: 840; Hill et al., 1979: 136-137). The decision tree is especially valuable as a visual aid in complex decision situations.

(3) Simulation Model

The simulation model is preeminently suited to computerized implementation. A mathematical model of the situation is set up and supplied with numerical data on current conditions, alternatives and possible outcomes. The simulation can then be run to predict possible outcomes under various sets of data (Kast and Rosenzweig, 1985: 436-439). Simulation models are valuable for examining rapidly many alternatives and possible outcomes. However, the reliability of the results depends entirely on how realistic is the model, and it is often difficult to model real life situations in mathematical terms and be sure that some vital element has not been omitted (Webster, Reif and Bracker, 1989).

Apart from these, there are other decision aids which are available to help managers cope with complex problems. These tools include: (1) linear programming, (2) game theory, (3) queuing theory, (4) forecasting, and (5) decision support systems.

(1) Linear programming. Linear programming is a mathematical technique for finding the maximum or minimum value of a function of several independent variables. It is useful, for instance, in making decisions on how to allocate resources among many product lines in order to achieve the optimum return (Hill et al., 1979: 178-179).

(2) Game theory. The competitive and conflict situations of business can be modelled as a game in which two or more opponents are each trying to achieve the maximum payoff; and the theory originally developed for games of strategy and chance can be usefully employed by the manager in choosing the most effective strategy under these conditions (Weber, 1982: 675).

(3) Queuing theory. Production lines and service provision points are subject to bottlenecks where workers or customers must, literally or figuratively, wait in line for service. Queuing theory is the mathematical tool for studying such situations and choosing conditions for optimum service with minimum waiting time (Shannon, 1985).

(4) Forecasting. "Forecasting" here refers to a specific planning and decision making procedure that endeavours to predict future trends and eventualities and so lower the level of uncertainty that besets many managerial problems.

(5) Decision support systems. Decision support systems are computerized information handling systems intended to aid management to come to decisions in complex, unprogrammed situations.

7. The Synectics Model of Problem Solving and Decision Making

Synectics originated in a study of creative thinking, especially in the fields of science and technology. Though creative geniuses are usually considered unique, a study of innovative thinkers reveals certain habits of thought which can be deliberately practised and cultivated. Though there is no reason why the techniques of synectics - like other idea generating techniques - cannot be used by an individual working alone, the process was developed for team operation.

The problem or objective will be presented to the team by a client who is the problem owner, who has the final responsibility for selecting and implementing any solution. Typically, synectics is applied to such situations as developing an entirely new product to meet a perceived market need or function. The team's objective is to develop one or more innovative solutions. A team leader coordinates the group's efforts and ensures that the process keeps on track of the required objective.

As described by Lambert (1996: 127-132), the process starts with the presentation of the problem by the problem owner. This stage, the Problem As Given (PAG) has four key elements:

(1) The problem specification and background from the perspective of the problem owner.

(2) The problem owner's ideal or preferred solution, if any. This solution is not constrained by any considerations of feasibility. The client has the opportunity to wish or to dream; the eventual role of the group is to provide the ideas which will develop a solution as close to that dream as practicality allows.

(3) Why it is a problem to the individual who owns it. Those aspects of the problem that affect him or her personally.

(4) Limitations on the problem owner's power to act in implementing a chosen solution.

During the PAG, the team members will note down keywords related to ideas that come to mind as they listen. These fragmentary ideas will provide the starting point for the next stage.

Following the PAG, the leader asks the team to express their initial thoughts in short statements or "headlines" which are displayed around the room. In the discussion that follows, an attitude of game playing is adopted. As in brainstorming, a free flow of ideas, without critical evaluation, is encouraged. The leader may take the group on an "excursion," an exercise to free thought and lead to greater creativity. A favourite example is story telling, in which each member adds his or her contribution in succession.

Much use is made of techniques which emerged out of the original study of creativity. These include: (1) Deferment - looking first for a viewpoint rather than a solution. (2) Autonomy of object - letting the problem take on a life

of its own and speak for itself. (3) Use of the commonplace - taking what one is familiar with as a starting point to leap into the unfamiliar. (4) Involvement/ detachment - alternating between going into the details of the problem and standing back to see the problem as a whole. (5) Use of metaphor, analogy and fantasy.

The client invites team members to explain ideas of interest in more detail. Eventually, an idea will emerge which appeals to the client as worthy of further development. The task now becomes that of developing this idea into a practical proposal capable of implementation.

A technique known as "Conditioned or Positive Response" has been found useful at this stage. The client first discusses the idea with its creator to ensure that it is clearly understood. The client then identifies a minimum of three benefits that would result from implementing the idea. By expressing specific areas of concern that remain to be satisfied, the client is also able to direct the development of the solution which most closely approximates to the ideal. At each stage of development the procedure is repeated until either an optimum solution is reached, or - the team must go back to the beginning.

The final solution is expected to be feasible, novel and so attractive to the client that the latter can hardly hold back the enthusiasm to implement it without delay.

8. An Example of an Improved Problem Solving and Decision Making Process for the Modern Thai Organization

Most Thai organizations have adopted the ZOPP technique and adapted it to their own particular problem solving situations (Hamilton and Gaertner, 1992). GOPP, "Goal Oriented Project Planning" is an English rendering of the German ZOPP, "Zielorientierte Projektplanung."

There are two main steps to the ZOPP technique:

(1) ***Problem Analysis***, which has four main aspects: Problem Analysis, Objective Analysis, Alternatives Analysis and Participation Analysis.

(2) ***Project Planning***, which uses a Project Planning Matrix (PPM) of 16 blocks, derived from the Logical Framework Technique of Project Planning.

For problem solving and decision making, ZOPP employs a brain-storming technique of problem analysis, together with visual aids such as colour cards for each participant to write on the problem, a flipchart for the use of the moderator, and a board for displaying selected cards.

Problem analysis is a technique for analysing the environmental situation and the existing problem at that particular time, determining the important problems and the main problem of the situation considered, and showing their cause and effect relationships in the form of the Problem Tree.

An example of problem analysis making use of a problem tree is as follows:

(1) Identification of the major problem within each situation.

(2) Writing down the major problem in the form of a short sentence.

(3) Writing down the cause of the major problem.

(4) Writing down effects that follow from the major problem.

(5) Writing a chart showing cause-effect relationships in the form of a problem tree.

(6) Considering the chart overall, as to whether it is reasonable and complete.

An example of a major problem is as follows:

(1) Write out the problem by identification of negative conditions.

(2) Use one card per problem (do not write more than one problem on one card and not more than three lines).

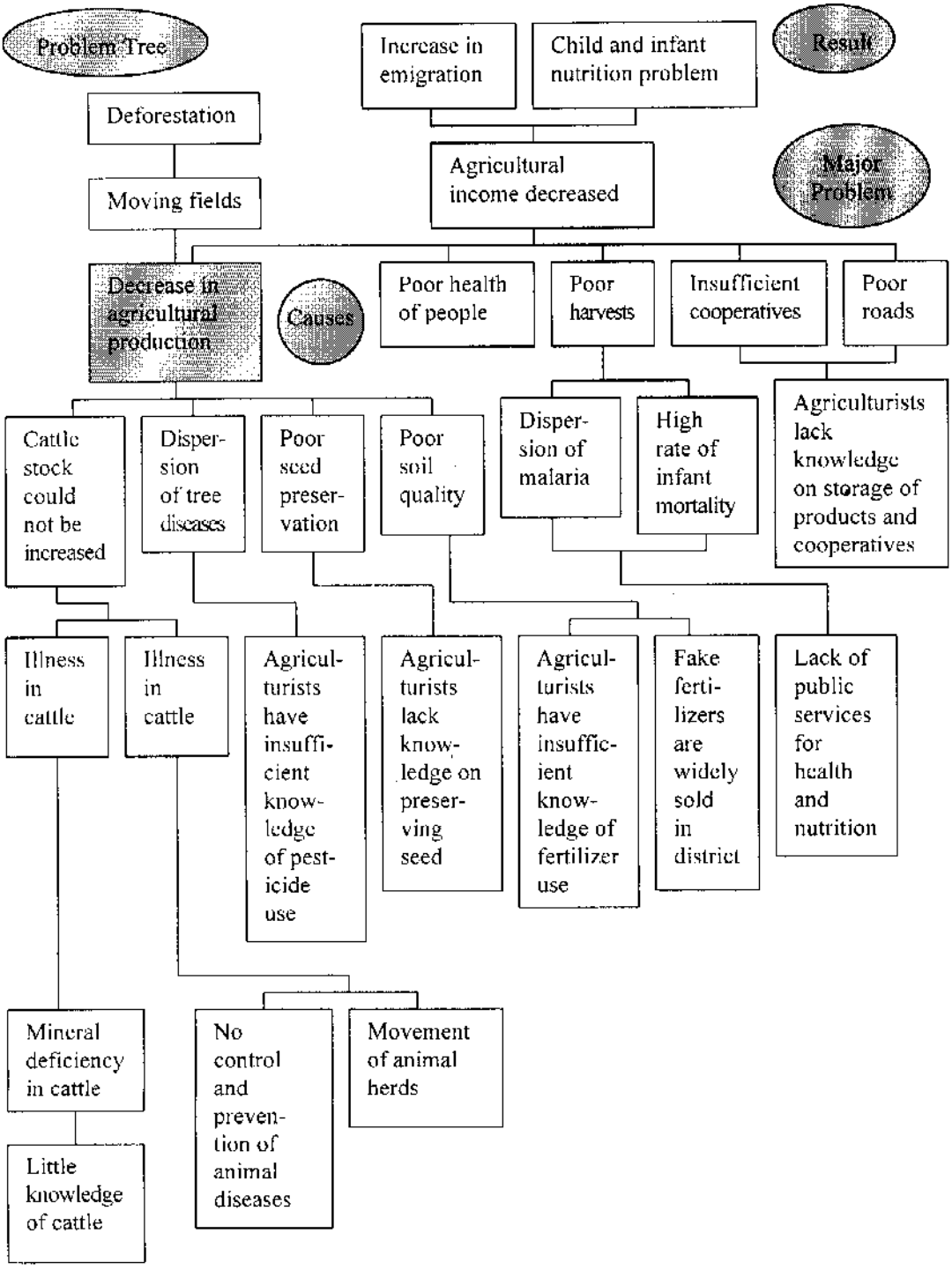
(3) Identify the problem arising at present, not prospective, possible or imaginative problems or problems which might occur in the future.

(4) Do not identify the problem in a way that negates a solution but merely identifies the existing negative state. For example, it is wrong to write that "There is no pesticide," but it is correct to write that "Plant products were destroyed."

(5) The position of the problem in the problem tree does not show the problem's significance.

An example of a problem tree is shown in Figure 1.

Figure 1 Problem Analysis According to the Problem Tree



After setting up the problem tree, the next step is to create the Objective Tree by objective analysis, in order to identify the future situation to be attained after solving the problem as well as to determine the alternatives possible in project management.

As far as the objective tree is concerned, the procedure is as follows:

(1) Change the negative statements of the problem tree to positive statements which express required states as well as ones which can be practically implemented. One should be careful that this is not just a verbal change but one which expresses a real situation. If such a situation is possible, one should consider whether it could be attained. The sentences are usually in the passive voice. For example: "The situation is improved."

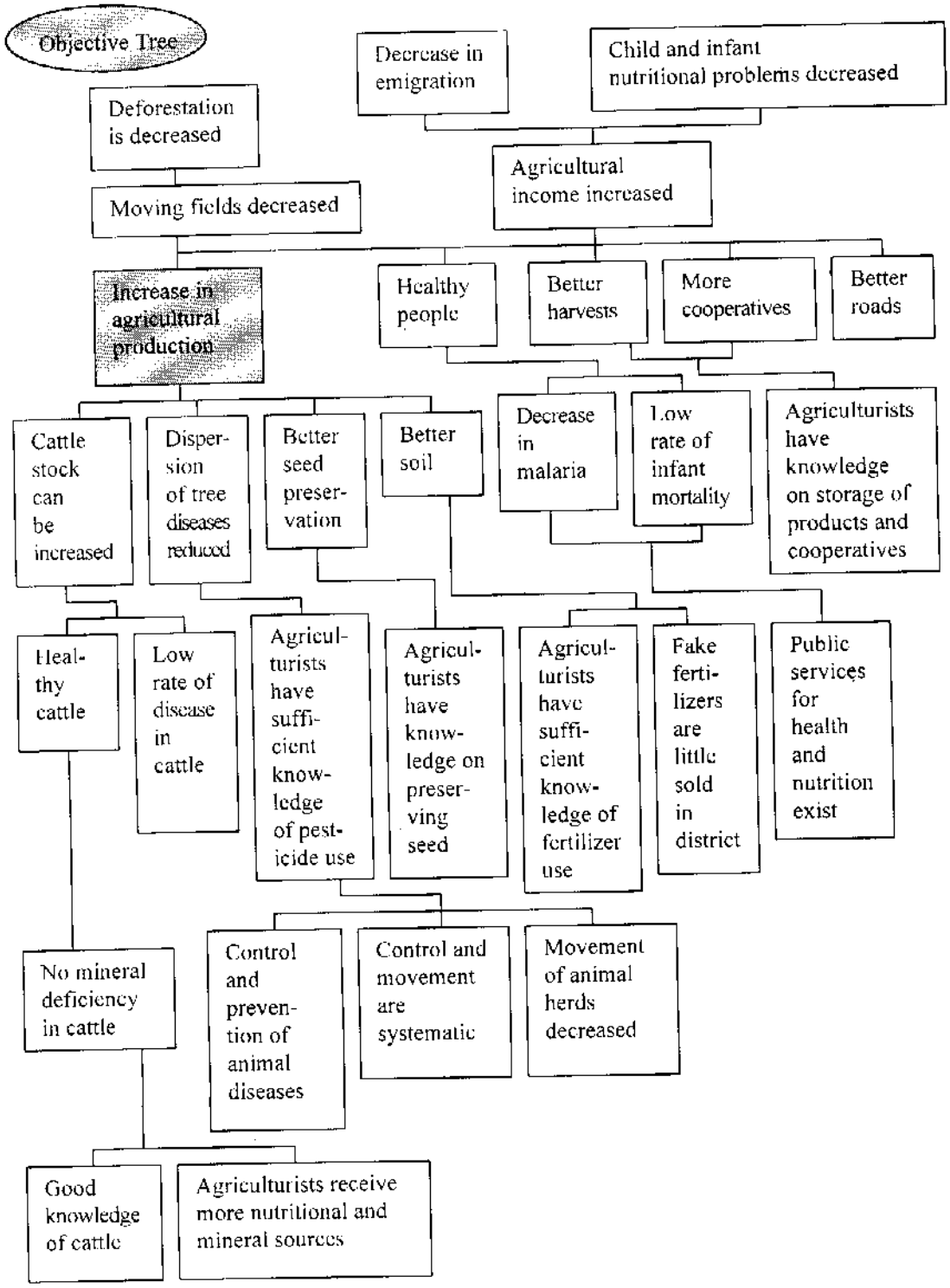
(2) Assess the means-ends relationships as to whether they are reasonable and complete.

(3) If necessary, one should proceed as follows:

- Review and change the determining statements.
- Add objectives that are considered relevant and necessary in order to fulfill the upper level objectives.
- Remove objectives that are considered not to be useful or not necessary to the project operation.

The following Figure 2 is an example of an objective tree.

Figure 2 Objective Analysis According to the Objective Tree



After setting up the objective tree, the next step is Alternative Analysis. Alternative Analysis is a method to: (1) determine alternative ways to problem solution which may be used as strategies or approaches to project operation, (2) select strategies or approaches to project operation from the possibilities thus found, and (3) make a decision to select one only from these strategies or approaches.

The method of Alternative Analysis is as follows:

(1) Cut out the unoperable, or otherwise unwanted, objectives.

(2) Determine a selection of ways or factors for project operation by trying to link methods with outputs or results in various patterns.

(3) Consider whether any of these alternatives can be used to achieve the maximum benefit, according to the following criteria:

- Already existing resources.
- Possibility of reaching the given objectives.
- Political feasibility.
- Cost-benefit ratio.
- Degree of social risk.
- Time period allotted for project operation.
- The possibility that the project will be self-sustained in the future.
- Other relevant criteria.

After making a decision, the next step is to draw up the Project Planning Matrix (PPM). The PPM summarizes in one page with 16 boxes the main project operational plan under the following points:

- Why must one implement the project?
- What result or output is desired from the project?
- How will the project arrive at the desired result/output?
- What external factors are important to the project's success?
- Where can one find the data or facts required for project evaluation?
- What budget is required to implement the project?

After careful consideration of these questions, the appropriate entries must be made in the 16 boxes of the PPM, as in the example shown:

Project Planning Matrix (PPM)

Project Title: Dindaeng District Development Project

Period of Operation: 1996-1998 Date of Preparation: Day/month/year

Project Organization: Dindaeng District

Summary of Objectives of Activities	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Economy and public health to be improved.	Agriculturists' income in Dindaeng district to increase by 10% per family ; improved public health ; basic family needs met by more than 80% by 1998.	- National Statistical Office Report. - Ministry of Public Health report.	-
Project Purpose Agriculturists' income increased.	Income from sales of rice to have increased by 15% per year by December 31, 1998, as compared with 1996.	- National statistical Office report. - Ministry of Public Health report.	-
Project Outputs Results 1. Rice production increased.	Every village in Dindaeng District to produce not less than 50 thang[1]/rai[2] rice by 1998 and of better quality than in 1996.	- Report of the Office of Agriculture. - Report of Project Progress.	Price of rice does not decrease.
2. Number and quality of cattle increased.	80% of cows to give birth to at least one calf; all cattle free from disease by December 31, 1998.	- Report of Provincial Cattle Office. - Report of Project Progress. - Report of Provincial Cooperative personnel.	Border situation peaceful (close to Myanmar).
3. Cooperative integration increased.	Every village to have at least 2 cooperative groups, operating under terms set up by cooperative, by December 31, 1997.	- Report of Provincial Cooperative personnel.	

1. Unit of quantity of rice (1 thang is equal to 20 litres).
2. Unit of land area (1 rai is equal to 1,600 square metres).

Summary of Objectives of Activities	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
4. Better public health.	From the year 1996, through the project period (1997-1998), physique to have improved and malaria incidence decreased by 50% in every village.	- Report on study of malaria by the Office of Provincial Public Health. - Report on death rate by the Local Administration Office.	
5. Project management efficient.	Within 3 months of commencement, one Project Office and 5 Field Offices must be set up. There are to be 25 persons ready to operate the project and a system of work.	- Minutes of meetings. - Report on Project Progress.	
6. Roads to be improved.	Natural stone (not asphalt) road from Dindaeng District to Tak Province, 60 km., width 6 m., to be made ready for use within 4 months.	- Report of the Office for Accelerated Rural Development.	
Project Inputs/ Activities 1.1 Training/ demonstration on fertilizer use and soil conservation. 1.2 Training/ demonstration on pesticide use. 1.3 Training/ demonstration on preservation of seed for agriculture.			Not more than one month without rain. Border situation peaceful. Target group must implement knowledge from training course. Agriculturists cooperate with projects Nos. 2, 3.

Summary of Objectives of Activities	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
1.4 Service personnel will investigate fake fertilizer sales. 1.5 Training of Karen (minority group on Thai-Myanmar border) leaders in agricultural knowledge. 1.6 Promote Karen leaders after training. 2.1 Meeting to request cooperation from Abbots of local Buddhist temples. 2.2 Training for housewives. 2.3 Training of volunteers in cattle husbandry. 2.4 Setting up of unit for prevention and treatment of animal diseases. 2.6 Demonstration on use of nutritional supplements. 2.7 Distribution of nutritional supplements. 2.8 Dissemination of information through radio tower at village. 2.9 Vaccination campaign against animal diseases. 2.10 Set up fencing to prevent vaccinated animals from straying. 3.1 Arrange a meeting of agriculturists. 3.2 Recruit members. 3.3 Set up a cooperative group. 3.4 Arrange a meeting of members to select a Committee. 3.5 Train the cooperative Committee.			Anti-malarials will give protection against disease. Cost of production increased by not more than 5% from 1986.

Summary of Objectives of Activities	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
3.6 Decide on marketing. 4.1 Train housewives in mother and child health. 4.2 Hold training/ demonstration on nutrition for housewives' group. 4.3 Provide testing and care in pregnancy, before and after birth. 4.4 Provide information on prevention of malaria. 4.5 Provide treatment for malaria. 4.6 Train Karen leaders on mother and child nutrition, and on malaria. 5.1 Set up an annual operational plan for the project. 5.2 Set up a financial and accounting system. 5.3 Hire and recruit project personnel. 5.4 Set up personnel development project. 5.5 Set up a system for determining project progress. 5.6 Follow up project operation. 5.7 Evaluate the project. 5.8 Arrange a meeting to announce the project results to concerned agencies. 5.9 Hold a dinner party for involved personnel. 6.1 Decide on a date to commence road development.			

The ZOPP technique's use of a project planning matrix as above is based on the Logical Framework technique originating in the United States. The steps in filling in each of the 16 boxes may be further described as follows:

1. Determining the overall goal and project purpose.

(1) The project for implementation will be selected from the objective tree and recorded in the first column:

- From the topmost cell downwards.

- Placing the long-term or overall goal in cell no. 1, and project purpose in cell no. 2.

- If necessary, revising the wording of the object tree to make the statements more accurate and readable.

(2) The project purpose usually specifies the benefits which are required or expected for the future. Success in terms of the project purpose will speed the project implementation towards its long-term goal.

(3) The project outputs/results are specified in the form of a target which the project manager must continuously strive to reach. They are appropriate, important, necessary and sufficient for the operation to achieve its final purpose.

(4) Inputs/activities are aimed at achieving outputs/results:

- Activities illustrate the project and its basic approach. Excessive detail is not needed.

- Unlike project purposes and outputs, activities are specified in sentences that begin with a verb. Thus: Project output - Promote agriculture. Project input/activity - Train part-time personnel.

(5) Allot a number to each project output and input/activity. These may identify the priority of the operation or the importance of the topic.

(6) In the means and outputs/results cell, place:

- The activity determined in order to reach the output, and the project input.

- The outputs and inputs, including important assumptions necessary in order to reach the project purpose.

- The project purpose is one which must succeed before the long-term goal can be reached.

2. Determining objectively verifiable indicators.

(1) Indicators will define the content of the overall goal, project purpose, outputs and inputs. Both overall goal and project purpose will involve the following factors:

- Time period (when).
- Area of operation (where).

- Target group (what and who).
- Cooperating organizations (at what place).

(2) The indicators will help one to ascertain how much progress has been made towards the project purposes, and to what level. One must have as many indicators of quality and quantity as one can find: direct, proxy and substitute indicators for use as appropriate.

(3) One must determine how one will assess progress towards the project purpose quantitatively.

(4) The methods of assessment must have validity and clarity in order that the results of assessment are in accordance with the project purpose. Each indicator must give the same result, whenever and by whomsoever it is used.

(5) Characteristics of good indicators are:

- Correctly, sufficiently and clearly reflecting the main content of the overall goal or project purpose.
- Related to the means and results of the master plan: making statements of quality and time required to achieve success at the upper level.
- Any change which occurs and is recorded will be directly related to and coincident with the project.
- Free from operational factors put into the project and able to measure the level of success in accordance with the project purpose.

(6) In the beginning, indicators will assist quantitative analysis of the concepts of the project. We shall ascertain whether the operational factors will attain the given quantitative level. These indicators must be reviewed in the project field and possibly changed in order to be more appropriate to the project.

3. Determining means of verification of project results.

(1) Determine sources of data to be used in monitoring the results of implementation, as revealed by the objectively verifiable indicators.

(2) The means of verification will be stated in the third column of the PPM. The data needed will be described and if possible the source of data specified. The means of verification should be numbered to coincide with the indicators required for each means of verification.

(3) When using means of verification that require data from outside the project, we must consider:

- How much data on the location and target group is required.
- How reliable, up-to-date and readily accessible are the data.
- Content and means of presentation of data.

(4) If means of verification are not available from outside the project, the project itself must collect, analyse and record data required by the relevant indicators.

(5) Collection, processing and recording of project data and the procedures for obtaining it must be recorded in the matrix under inputs or activities.

(6) If the project planner cannot find evidence to verify the indicators specified, new indicators requiring other means of verification must be found.

(7) If the means of verification are excessively expensive when considered in terms of the benefit-cost ratio, they should be replaced by indicators which are easier and cheaper to use.

4. Consideration of how much external factors are related to the project.

(1) The important assumptions must be clearly stated and capable of being determined in the future, both qualitatively and quantitatively, by means of the indicators.

(2) The important assumptions related to each activity must be clearly determined. This is a basic condition of project operation.

(3) Assumptions required before each step in the project should be indicated by a mark (such as !).

(4) Consider again whether assumptions are likely to be realized and to affect the project much. If one is doubtful or impossible, it should be marked (for instance ?).

(5) Necessary assumptions should be realizable and relevant to the project. Assumptions which may not certainly be realized are known as "killer assumptions," "threats," or "obstacles" and may show that it is impossible to implement the project.

(6) Killer assumptions, or obstacles, are conditions that may blockade the project if no other approach can be adopted to solve the problem or reduce the risk.

(7) Solutions must be improved and inputs (activities) and outputs (results) changed until the obstacle is removed.

(8) The overall risk of the project comprises a risk ratio for the project and unforseen negative factors which may arise. It is therefore necessary to clearly evaluate the overall risk ratio of the project.

5. Evaluation of suitability of project management.

(1) After quantitatively analysing the risk ratio in the assumptions, one must investigate various factors under the control of the project and project management, as well as determining the scope of responsibility of the project for its major output, which must be reproducibly implemented.

(2) To investigate the various factors under the control of the project and the determination of what can be successfully brought within the scope of the project - to determine the duties of the project manager, in order to achieve the major activity or output - needs official consultation outside the boundary of the ZOPP planning technique itself.

(3) Factors under the control of the project can be determined by considering the following:

- The location and time of project commencement,
- Objective,
- Risk rate.

(4) The project management group must be in full agreement and able to guarantee implementation to achieve the major activities and outputs. This will ensure fulfillment of the project's purpose, because there will only be official commitment when what is to be done can be genuinely and successfully implemented.

(5) The project management organization may comprise only part of the project personnel, or may involve cooperation between personnel responsible for every part of the project. Responsibility must be specified in the project contract and agreement, as well as in contracts for hiring of personnel.

(6) Planning should determine status and roles, as well as responsibilities at every level, according to requirements and feasibility.

6. Determination of budget and resources necessary to each activity under the project.

(1) The quantities of material, workforce and expense budget required for project implementation must be determined.

(2) Project financing means cash expenses, not including materials and salaries of personnel.

(3) Personnel rate factors will be calculated as man-months for any activity.

(4) In determining materials, one should list materials to be used first; for instance: seed rice 100 tons, caterpillar tractors 2 and so on. Then one should allocate the percentage of time to be spent on each activity and sub-activity.

(5) After estimating the expense budget and resources required for operation, one must again review the operational approach to the project.

- Determine the quantity of resources necessary for each major activity and result.
- Conduct a cost-benefit analysis, list priorities of major activities and results, as well as their consequences, which may promote attainment of the project's intended purpose.
- Estimate the expenses and operational resources which may be used or allocated, from an analysis of the rate of risk.

(6) When budget resources determine the scope and expenses, as well as operational resources to be provided, one must once again quantitatively review and assess the project and determine the options as to what can and cannot be used to successfully achieve the project's major result.

(7) There must be a qualitative review of plans for expenses in case details of operation give rise to problems in the event that:

- The rate of power consumption, in one form or other, is too high.
- It is necessary to spend foreign currency.
- It will be necessary to depend on imported items for some time.

- The budget for project implementation, or maintenance after completion of the project, is too high.
- The specified activities do not make full use of the workforce, or do not equip the target group to be self-reliant.

(8) Determination of the details of operational resources is basic to determining the budget for project implementation as well as calculation of overall expenses.

9. Conclusion and Recommendations

The modern Thai organization has seen a change in the process of problem solving and decision making. In the past, the organization left the task of solving a problem and coming to a decision to an individual or group of concerned managers.

About 20 years ago, Thai organizations adopted the American technique of problem solving known as the Logical Framework. The project manager uses a logical framework to plan his project. Project planning mainly involves problem solving by a team and brainstorming which still mainly depends on verbal discussion. Latterly, the German ZOPP technique has adopted the Logical Framework and improved upon it by employing written cards during brainstorming.

At present, many Thai organizations use the ZOPP form of the Logical Framework technique for problem solving and decision making as part of their project planning. This is especially so among Thai government agencies and state enterprises, as well as large private corporations.

The ZOPP technique is however only one technique among many. Many techniques have been developed for enhancing creativity and promoting innovative thinking, and are at present underused. Their use needs to become habitual. Perhaps they should have been introduced into the education of the prospective manager long before he or she comes to assume managerial responsibility.

It is clear also that there needs to be a greater awareness of information. One might wonder how many millions of dollars have been spent on "buying" technology and know-how that is freely available in a library if one knows where to look for it, and which requires only local technical, engineering and managerial expertise to implement.

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