

AN MCDM PROBLEM IN BANKING

Dr. Jan Telgen
Senior Consultant
DEPT. OF APPLIED MATHEMATICS
Rabobank Nederland
Laan van Eikenstein 9
3705 AR ZEIST
THE NETHERLANDS

October 1982

This paper will appear in: P. Handen (ed),
Multiple Criteria Decision Making V,
Springer Verlag (1982)

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Jan Telgen
Department of Applied Mathematics
Rabobank Nederland
3705 AR ZEIST
THE NETHERLANDS

ABSTRACT

Rabobank is a cooperation of approximately 1000 banks with nearly 3000 offices. Top management of the central organisation, Rabobank Nederland, has set a number of goals for the organisation. The goals are stated in terms of totals of balance sheet items that should equal a certain amount.

On the other hand individual departments of Rabobank Nederland predict or plan the amounts for the individual balance sheet items, without reference to the overall goals.

Finally, the cooperating banks and the market determine the amounts of different categories of funds that can be used by Rabobank Nederland.

To manage the balance sheet composition all three kinds of "data" have to be integrated. This is accomplished in a mathematical programming model with multiple criteria expressing the interests of all parties.

1. Introduction

In Holland there are nearly 1000 Rabobanks each operating in its own geo-geographical region completely independent of the others. All these Rabobanks together have founded a cooperation that takes care of that part of banking business that can be handled more efficiently by a central (and larger) organisation, such as foreign affairs, high risk investments, money market transactions and automation. As a consequence of this organisational scheme, the central organisation, called Rabobank Nederland, should be considered as a daughter of 1000 mothers, which is essentially different from the rather common construction in which the central organisation is the mother of a number of daughters. Thus Rabobank Nederland is limited in its possibilities to manage and direct the consolidated corporation.

All individual Rabobanks have an account with Rabobank Nederland in which they hold approximately 25% of their assets. It is the responsibility of Rabobank Nederland to use these funds in such a way that all of its own activities can take place. At the same time the resulting balance sheet composition of Rabobank Nederland is a major instrument for corporate management to direct the development of the

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consolidated corporation.

The operations Research group was called upon to assist in the conciliation of management desires, uncertain forecasts and the need for funds for certain activities.

2. THE PROBLEM

Top management of Rabobank Nederland controls the development of the organisation by comparing the "budgeted balance sheet" for one year ahead and the current situation. In the past this budget balance sheet was composed of aggregated data from different departments (e.g. loans, savings etc.) within Rabobank Nederland. These bottom-up data were partly forecasts, partly plans, partly budgets, but all based on the interests, knowledge and horizons of individual departments. Apart from simple checks on balance sheet totals etc. no systematic effort was put into transforming these individual data into an overall plan or budget.

Of course top management of Rabobank Nederland has its overall view and overall goals, but no formal mechanism was available to integrate these top-down data with the budgeted balance sheet.

The desires of top management are mainly related to the amounts of funds (as a percentage of funds available) that are available for investment in certain sectors of the economy. All these desires can be expressed in terms of balance sheet items.

A complication is the uncertainty in the amount of funds available to the total organisation one year ahead. Since this is of the order of DFL 70.000.000.000.-, even a 10% change or a forecast that is 10% off could have dramatic effects.

On the other hand it is possible to be more or less active in attracting certain kinds of funds in order to achieve a limited increase or decrease in the amounts of funds available.

So the problem is to determine the composition of the balance sheet for Rabobank Nederland one year ahead, taking into account the desires of top management, the "budgets" of individual departments and the uncertainty concerning future funds available.

3. The Model

Of course the problem description as given in the previous section was not immediately apparent, but emerged only after a number of discussions. In the same way the modelling of the problem evolved during the process. To facilitate the presentation, we only discuss the model that is used now (June 1982).

The items to be determined are the amounts of money allotted to the different accounts in the balance sheet.

We denote them as:

a_i : amount of money allotted asset i
 $i = 1, 2, \dots, n_a$

l_i : amount of money allotted to liability i
 $i = 1, 2, \dots, n_l$

Of course the balance sheet totals should match:

$$\sum_{i=1}^{n_a} a_i = \sum_{i=1}^{n_l} l_i$$

Furthermore there are legal constraints on the liquidity of the total Rabobank organisation. Fixed percentages of the amounts involved in certain liabilities should be kept in short-term assets. Since Rabobank Nederland is required to fill any gaps, the individual Rabobanks leave in this respect the liquidity constraint can be formulated as:

$$\sum_{i=1}^{n_a} q_i a_i > \sum_{i=1}^{n_l} r_i l_i + g$$

in which q_i and r_i are legally required and fixed percentages and g is the "liquidity gap" resulting from the individual banks.

This gap is defined as:

$$g = \sum_{i=1}^{n_m} t_i m_i - c$$

in which:

m_i : means (liabilities) of the individual Rabobanks of type
 $i : i = 1, 2, \dots, n_m$

c : amount of cash money with the individual Rabobanks

and t_i are legally determined and fixed percentages.

From this definition one can see that the individual Rabobanks do not engage in short-term assets (money market etc.), but use their account with Rabobank Nederland in that way.

Other constraints are formed by upper and lower bounds (some logical, some managerial) on all variables a_i , l_i and m_i . In addition upper and lower bounds are specified for the balance sheet total

$$\sum_{i=1}^{n_a} a_i$$

and the total of all means with the individual banks

$$\sum_{i=1}^{n_m} m_i$$

Management desires can be expressed as functions of individual balance sheet items:

$$\sum_{i=1}^{n_a} f_{ij} a_i \quad j = 1, 2, \dots, n_f$$

which should equal fixed percentages of the total of all means with the individual banks:

$$F_j \cdot \sum_{i=1}^{n_m} m_i \quad j = 1, 2, \dots, n_f$$

Deviations of these desires are denoted as d_j^+ and d_j^- in

$$\sum_{i=1}^{n_a} f_{ij} a_i = F_j \cdot \sum_{i=1}^{n_m} m_i + d_j^+ - d_j^- \quad j = 1, 2, \dots, n_f$$

To incorporate the forecasts, plans and budgets contributed by the individual departments of Rabobank Nederland, we define

$$a_i = a_i^b + a_i^+ - a_i^- \quad i = 1, 2, \dots, n_a$$

and

$$l_i = l_i^b + l_i^+ - l_i^- \quad i = 1, 2, \dots, n_l$$

With respect to the means available at the individual Rabobanks we define in a similar way:

$$m_i = m_i^b + m_i^+ - m_i^- \quad i = 1, 2, \dots, n_m$$

Now the goal is to minimize all deviations from the desires of top management, the budgets of the departments in Rabobank Nederland and the forecast of the available means with the individual Rabobanks.

In terms of the variables of the model this implies minimizing

$$d_j^+ + d_j^- \quad j = 1, 2, \dots, n_f$$

$$a_i^+ + a_i^- \quad i = 1, 2, \dots, n_a$$

$$l_i^+ + l_i^- \quad i = 1, 2, \dots, n_l$$

$$m_i^+ + m_i^- \quad i = 1, 2, \dots, n_m$$

4. Our Solution

The model described in the previous section comprises approximately 15 linear constraints in 200 variables. As such it is a small LP problem that can be solved routinely. However instead of one objective function we have to deal with approximately 100 objectives formulated by different levels of management.

Even specific MCDM methods can not cope with such a multiple of objective functions.

Therefore we have incorporated all objectives into a macro objective function consisting of the weighted sum of all individual objectives.

The weights in this macro objective function are the main instruments to derive an acceptable solution.

So we have a simple linear programming problem, that can easily be solved for different sets of weights. The problem now, is to do this in a systematical way, such that the decision makers are not confronted with too much trial solutions. To facilitate this the process of deriving an acceptable solution by tuning the weights is mechanized in an interactive computer program built around the linear programming subroutine.

Since there is no formal method available for this case we have to consider the specific problem setting for ways to cope with this problem.

As a starting point we only paid attention to the desires of top management, since these were expected to determine the general direction the bank has to move into. The balance sheet obtained in this way ignores the plans of the individual departments and the forecasts of the means available.

Now the next step is to identify all goals that can be achieved without worsening the achievement of top management goals. These other achievable goals included the major part of all individual department's plans. Consequently these balance sheet items were fixed at their budgeted value.

For the remaining non-achieved goals of top management and the individual departments (about 10 items in total) an interactive system was used for fine-tuning the weights in the objective function.

We realize that this approach does not necessarily lead to the overall-optimal solution, but this fact is considered less important than the practicality of the method.

In this (problem specific) approach the decision maker does not have to be confronted with vast amounts of data at every iteration in the process. His attention is focused upon those elements of the problem that cannot be easily solved. And for these he can evaluate a number of different solutions.

In this latter process the use of information contained in shadow prices proved to be very helpful.

5. Concluding Remarks

The lessons to be learned from this application are the following:

- (1) - Working with multiple criteria is a means to model situations in which it is not clear what is really wanted. It is not the solution that is most important, but the modeling itself. In our case the existence of conflicting goals and the degree to which they conflicted was only realized after the system was modeled.
- (2) - No formal MCDM method is capable of dealing with many objective functions. In such cases it is advisable to use the embedded (problem specific) structure to handle the problem. However, this also points out the need for a formal method that can handle these situations.
- (3) - It is not worthwhile for problem sizes like the one we are dealing with, to build fancy software to save advanced starting bases etc. We used LINDO and in no instance it took more than 3 CPU seconds (DEC 2060) to compute a new solution. Also its interactive capabilities are a great asset in these problems.
- (4) - If it is possible to get the decision maker to become acquainted with the model formulation in mathematical terms, this is very helpful. Especially the input formulation for LINDO will become clear, and thus the black box of solving the LP will be less threatening. This may be very advantageous when it comes to implementing the results.