

## POSSIBILITIES FOR APPLICATION OF OPERATIONAL RESEARCH TO PROBLEMS OF DEVELOPMENT\*<sup>1</sup>

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The organizers of this meeting have asked me to summarize the discussions of the last three days and to draw some conclusions. These will have to be provisional and personal conclusions only, formulated in all modesty, since I am not an expert in several of the more sophisticated methods discussed here.

While the term "operational research" has not, as far as I know, a very precise meaning, we may nevertheless characterize it by:

- (1) treating complicated problems with a large number of variables;
- (2) using various modern mathematical and logistic methods; and
- (3) being directed toward a goal of action.

Its success has been proved already especially solving a number of problems in manufacturing industries, transportation and energy, fields for which usually precise and abundant data are available which make it worthwhile applying sophisticated methods.

When we ask whether this complex of methods can also be applied to development problems, it seems appropriate to summarize also what seems to be characteristic for these problems. We may say they are characterized by:

- (1) great complexity, requiring the cooperation between very different types of experts;
- (2) for their solution they require the cooperation of governments as well as citizens of developing countries which gives particular importance to the necessity of communication between planners and the groups mentioned;
- (3) for the solution of development planning problems only a restricted number of qualified experts is available;
- (4) the situation in the countries concerned is characterized by lack of capital;

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<sup>1</sup> This paper is an English translation of Professor Tinbergen's summarizing remarks at the close of the recent Symposium on the Possibilities of Operations Research in Developing Countries, held in Paris, June 26, 27, and 28, 1963. This Symposium was organized by the Société Française de Recherche Opérationnelle with the participation of The Institute of Management Sciences, The Operations Research Society of America, and The Operational Research Society of the United Kingdom. This paper will be published in the *Actes du Colloque de Paris*. Queries about the papers should be directed to M. J. Weinbach, Société Française de Recherche Opérationnelle, 7<sup>ter</sup>, Rue de la Chaise, Paris 7<sup>e</sup>, France.

(5) in the small countries in the process of development (and there are many of them which are small) indivisibilities and external effects, as mentioned by Mr. Morton, play an important role;

(6) often the data available are of doubtful quality especially as a consequence of human reactions which intervene between the source and the receiver;

(7) the aims of development policy are often not clearly delineated as is illustrated by the well-known question whether or not the main aim should be balanced growth.

For the solution of these difficult problems clearly all available methods must be used. The whole field is one of pressing emergency. From our discussions we have seen that interesting partial methods are available from other fields, such as simulation, whether by computers or with the aid of games between experts as mentioned by Messrs. Helmer and Quade. Also, network planning as mentioned by Mr. Szuprowicz may be a useful partial method, especially with regard to the time structure.

A case may be made not to use too complicated methods, as advocated by M. Mercier and myself; simple methods facilitate communication between planners and policy-makers as well as between chief planners and their collaborators. Whether the quality of the data available is another argument in favor of simple methods, seems to me to be an open question. Also, it should not be forgotten that someday Professor Frisch, the proponent of complicated methods, may show us that simplified methods lead to erroneous results.

The possibility to work with a small number of sectors, as suggested by Mr. Sandee, encouraged us, however.

We should be concerned about the efficiency of our methods and not waste resources. Sometimes one feels that particularly in sociological research or in research for regional planning such waste takes place. Research should be directed, as much as possible, at the aims to be reached and not simply by curiosity.

Much advantage can be taken from international comparison as Mr. Wolf's contribution illustrates. Such comparisons can often fill the gaps in national data.

The examples given by the papers of this colloquium seem to show:

- (a) The use of directed research. We have had interesting examples of
  - (i) the *macro* stage of planning: the papers by M. Wanty on the role of increased savings, by M. Beyrard, and by Messrs. Lesourne and Olivier on the conditions for the eventual elimination of aid, and by Messrs. Leroux and Allier on the shifting of labor from the rural to the urban sector;
  - (ii) the *sector* stage: a large number of papers given here referred to sector problems.
  - (iii) the *project* stage: papers by Messrs. Sandee, Iribarne and Leveau on shadow prices.
- (b) As observed by Professor Perroux, most of the papers use relatively simple

methods: the experts in operational research may decide whether they consider them to belong to their field.

(c) Perhaps too many of the papers did not (yet) use figures—which may be due to a lack of data.

(d) Perhaps may I add that the range of subjects covered was, in my opinion, too wide. For a first orientation, there is no harm in this; but later conferences might be more fruitful when confined to a narrower field.

The econometrists among us have learned that we have spoken prose (I mean have done operations research) all of our life without knowing. We do have now some picture of what the problem area of development seems to be; our models and figures already reveal somewhat of a structure. Thus, as a first approximation, the set of the world's economies may be considered a one-dimensional set with income per head as the main determinant of most relevant variables. This seems to justify, as a first approximation, some simple and general theories of development. An interesting question is, however, what second and third determinants must be added if the theory is to be refined so as to cover both historical series and cross section figures. Is one determinant the international environment (think of how different this is for England around 1800 and India today); and is another the level of education?

Our image shows that capital coefficients, such an important instrument in our first approximations, show an interesting concentration for "international" industries while those for the "national" industries are situated at the extremes. (By national industries I mean activities whose products cannot enter into foreign trade.) This considerably reduces the possibilities for single countries to specialize on capital-intensive or labor-intensive activities.

Our picture also shows that only relatively few industries show a wide range of techniques, leaving a choice between capital-intensive and labor-intensive techniques within the industry. It looks as if the oldest activities (agriculture, building, textiles) are those showing a wide variety only.

Finally, it seems that in the same industrial "column" the activities closer to the raw material are more capital-intensive and those closer to the consumer more labor-intensive.

Our models have been verified only to a very limited extent. There are some good verifications of our short-term forecasts for Western European countries; is there much about long-term forecasts for developing countries?

Surely we have a number of urgent problems to solve and M. Massé rightly asked us which we think are the most urgent ones. My guess is the following. We urgently need

(i) more data on individual projects—always a bottleneck in development planning,

(ii) more attention for the problem of creating employment—maybe technicians should be asked more emphatically to develop labor-intensive modern techniques,

(iii) further research in the planning of education and training,

(iv) better methods for regional planning, and finally,  
 (v) a better knowledge of the external effects and the indivisibilities playing a role in our economies: it is these which necessitate deviations from the free enterprise system and their knowledge is also important therefore in the discussion with communist countries on the optimum organization of the economy.

Let us continue to work hard; the subjects and the aims are worth it; and let us have narrowly defined subjects for future conferences.

### Programme des Conférences

*Ouverture du Colloque par Monsieur Pierre Massé*

*1ère séance: mercredi 26*

Programmes généraux de développement C. GRUSON

G. MORTON "Models for social planning"

J. SANDEE "Essential accounting prices in development programming"

BOHDAN O. SZUPROWICZ "Network planning techniques in general development programs"

MORRIS J. SOLOMON "A system for project analysis and implementation in newly developing countries"

*2ème séance: mercredi 26*

Modèles de croissance P. C. MAHALANOBIS

J. WANTY "Considérations théoriques sur les possibilités de croissance d'une économie sous-développée"

O. HELMER et E. S. QUADE "An approach to the study of a developing economy"

CHEDLY AYARI "Le rôle opérationnel du capital/output ratio dans la fonction de production de la firme, dans les pays en voie de développement"

J. LESOURNE et R. OLIVIER "Détermination de l'aide extérieure nécessaire pour atteindre l'auto-développement"

*3ème séance: jeudi 27*

Recherche opérationnelle et théorie économique H. B. CHENERY

LEROUX et ALLIER "Fonctions de production à facteurs substituables". Essai d'application aux économies en voie de développement.

ARNOLD E. SAFFER "The transformation locus within a development plan"

M. LEVEAU "Le problème des critères pour l'industrialisation"

P. D'IRIBARNE "Coût du travail pour la collectivité et critère de choix des investissements dans les pays en voie de développement"

Déjeuner en commun Allocution de Monsieur FRANÇOIS PERROUX

*4ème séance: jeudi 27*

Industrie et transports M. MILLIKAN

KAN CHEN et W. K. LINVILL "Some special problems of electric power expansion in developing countries"

J. RAIMAN "Application possible de la recherche opérationnelle à un problème de tarification des transports en Afrique"

E. KLEINMANN "Problèmes de transports au Niger et au Dahomey"

ALBERT H. RUBENSTEIN "An analysis of alternative strategies for organizing the applied research activities of developing countries"

JAMES L. TAYLOR et JOHN E. WALSH "Simulation of military logistics operations in an under-developed country"

*5ème séance: vendredi 28*

Autres domaines d'application de la recherche opérationnelle

VICTOR E. SMITH "Linear programming and the attack on malnutrition"

S. MUSHKIN et L. REIFMAN "Health programming in developing nations"

N. BEYRARD "Prospective budgétaire et fiscalité des pays en voie de développement"

*6ème séance: vendredi 28*

Problèmes d'éducation and Conclusions J. TINBERGEN

RUSSELL C. COILE "Educational planning in developing countries"

HENRY F. McCUSKER, JR. "An approach for educational planning in the developing countries"

CHARLES WOLF, JR. "Some applications of operations research problems to economic development"

Conclusions par Monsieur J. TINBERGEN

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