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"Nowadays cybernetics has an increasing importance in the management of industrial and economical processes, in reducing the special productivity of man's work, in the overall progress of mankind"

NICOLAE CEAUȘESCU

from the Message addressed by the President of the Socialist Republic of Romania to the Third International Congress of Cybernetics and Systems.

The Efficiency-Profitableness System. Economic-Cybernetic Models of The System

The reaching of a high efficiency in all the compartments of the national economy space (Fig. 1) — from the fundamental unit up to the national economy ensemble-represents a decisive condition for ensuring high rates of economic growth, for a continuous increase of the people's material and cultural standard of living. Thus, the gradual decreasing and the erasing of delays keeping apart the developing countries from the economical advanced countries, can be assured.

The analysis carried out for the phenomena and processes taking place into nature and society striking emphasizes the universal character of the efficiency maximization law.

Two centuries ago, D'Allembert and then Hamilton and Jacobi have defined the variational principle of the minimum power consumption, the controling law of the physical bodies displacement.

This principle also acts inside every phenomenon under the physical space, from the light evolution on the shortest way, up to the law of bodies falling under the gravitational influence.

In contrast with the acting form of the highest efficiency law under the systems studied by the natural sciences, under the economic space this acting form grows extremely complex, it being the *vectorial resultant of a multitude of phenomena and processes*, sentient directed through the human activity, according to the objective necessities of the society development. *The highest efficiency law gets its plenary representation in the social-economic*

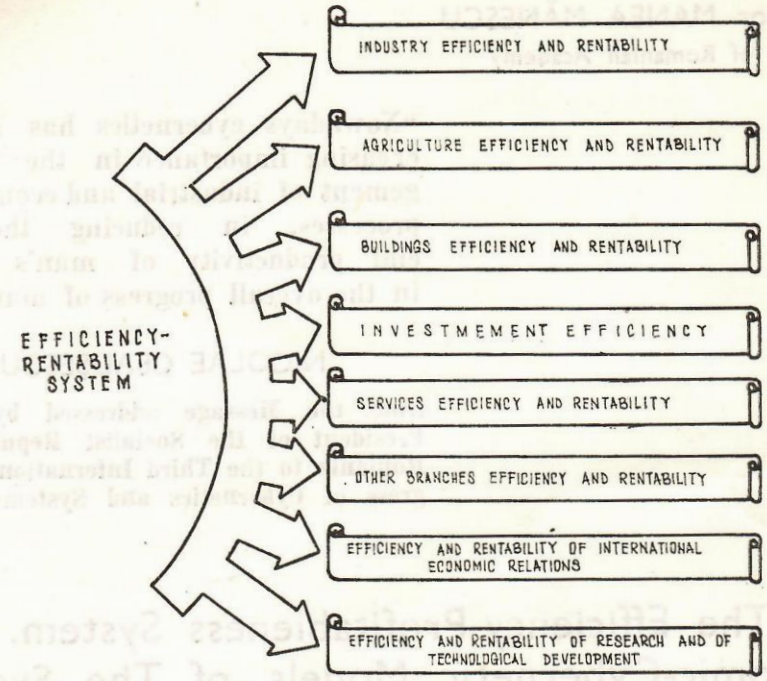

Figure 1

development programmes, which focuse the coordinates of the optimal and balanced dynamics of the whole complex of phenomena and processes taking place under the national economy space.

1. SYSTEM TOPOLOGY AND CONNECTIONS

The efficiency and profitableness play a very important part in the strategy and in the tactics of managing the general cybernetic system components, *of their placing along the growth trajectories.* The efficiency and the profitableness — as fundamental characteristics of the operations of the national economy general cybernetic system — are major criteria for appraising the performances of all the carried out activities within the frames of its components.

Essentially, the efficiency expresses, under different forms, the objective universal law of the sentient human activity — the saving of time — emphasizing the necessity of commensurability and of permanent comparison of expenses with the useful output of activities under the national economy space. The profitableness directly reflects the efficiency of every component of the general cybernetic system, forming a widely spreaded *optional criterion* for evaluating the efficiency rate of the activities taking place under the national economy space.

It must be emphasized that the efficiency and profitableness maximization law acts about every aspect of the reproduction process: production,

distribution, movement and consumption, imposing itself for every cell of the economic body.

Therefore, the efficiency-profitableness system is one of the systems through which the system of management, command, regulation and control synthetically measures the quality of the activities displayed at every level (Fig. 2). It may be appreciated that the efficiency represents one of the main key factors through which the management system acts about every component of the general cybernetic system with a view of assuring their evolution along the optimal growth trajectories.

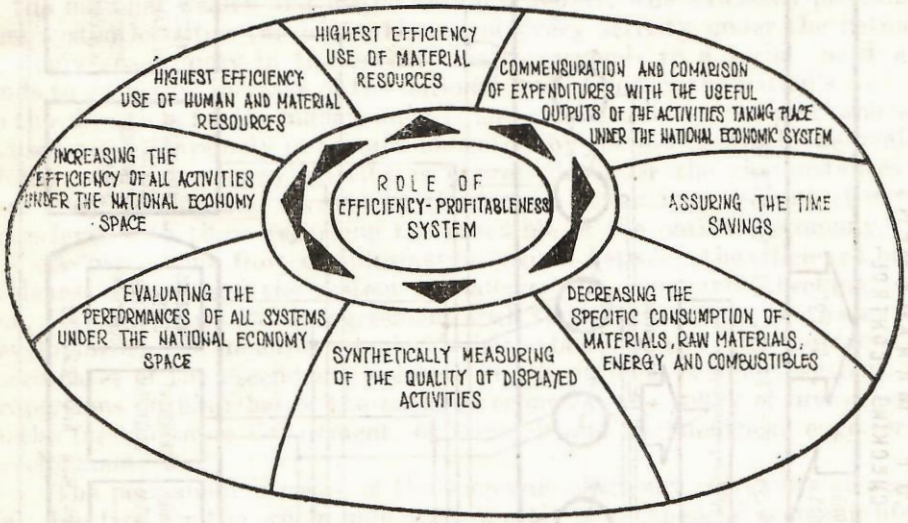

Figure 2

The immense variety of all these components and the special complexity of the relations between them objectivelly generates the necessity of a great variety of concrete action forms inside the efficiency field, expressed through the efficiency indicators system. Under the national economy space this forms a *force field* which directs the activity up to the level of every cell of the economic body. The connections established between the efficiency-profitableness system and other systems and subsystems evolving under the national economy space are just materialized in these concrete forms of impulses emitted from the decision body, with a view of increasing the efficiency in all the activity fields.

Under the general cybernetic system architecture of the national economy, the efficiency-profitableness system, connected to the labour productivity system, forms a basic tool through which the macroeconomic decision body directs and controls all the phenomena and processes taking place under the economic space, towards their convergence or highest efficiency. In order to fulfil the important task settled to it, the efficiency-profitableness system permanently harmonizes, *through some complex dialectical process*, the efficiency and profitableness criteria of every cell of the economic body with the overall criterion of the general system (Fig. 3). This is a sine qua non

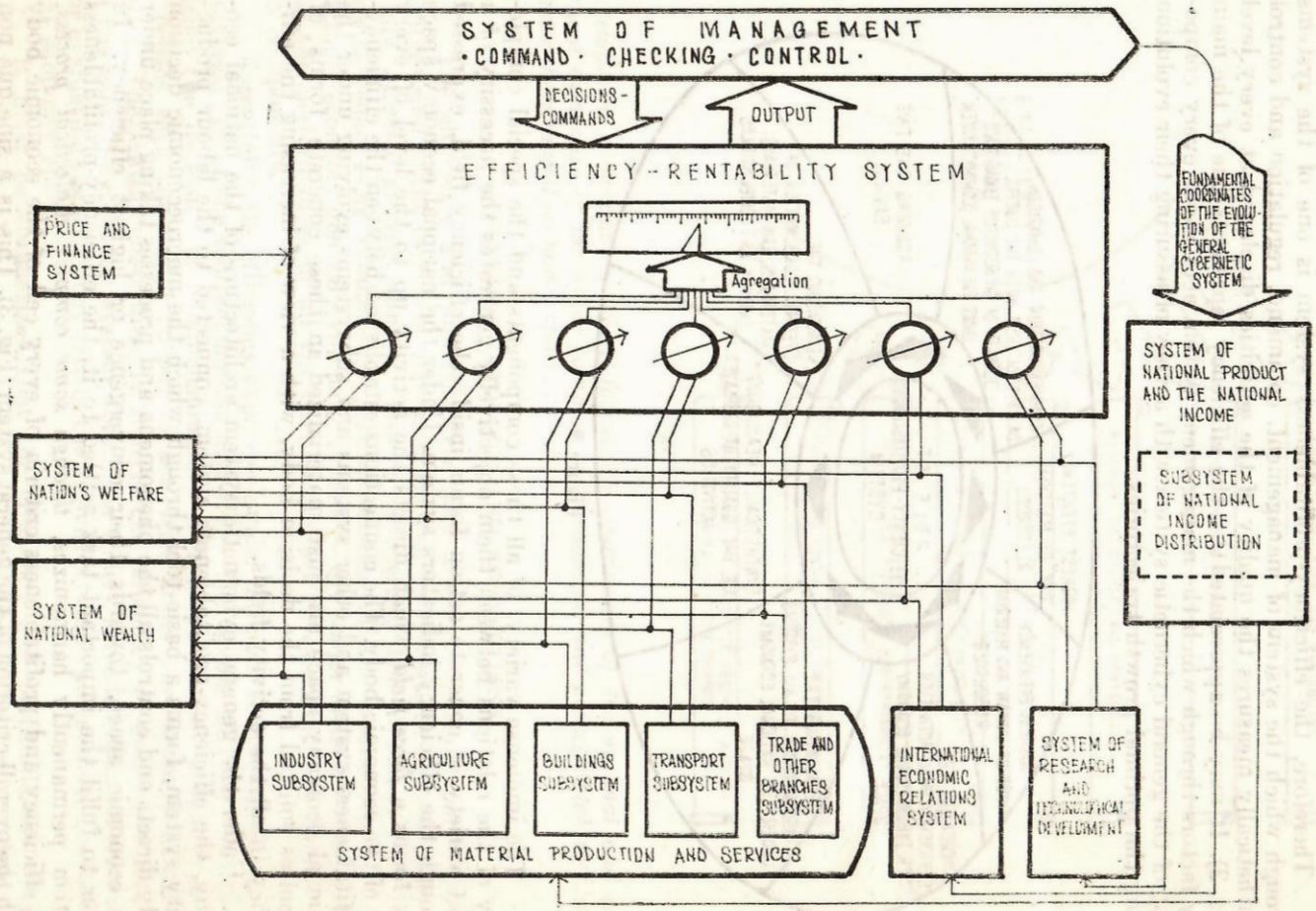
SYSTEM OF MANAGEMENT
·COMMAND· CHECKING · CONTROL·
DECISIONS - COMMANDS
OUTPUT
EFFICIENCY - RENTABILITY SYSTEM
Agregation
PRICE AND FINANCE SYSTEM
FUNDAMENTAL COORDINATES OF THE EVOLUTION OF THE GENERAL CYBERNETIC SYSTEM
SYSTEM OF NATIONAL PRODUCT AND THE NATIONAL INCOME
SUBSYSTEM OF NATIONAL INCOME DISTRIBUTION
SYSTEM OF NATION'S WELFARE
SYSTEM OF NATIONAL WEALTH
INDUSTRY SUBSYSTEM
AGRICULTURE SUBSYSTEM
BUILDINGS SUBSYSTEM
TRANSPORT SUBSYSTEM
TRADE AND OTHER BRANCHES SUBSYSTEM
SYSTEM OF MATERIAL PRODUCTION AND SERVICES
INTERNATIONAL ECONOMIC RELATIONS SYSTEM
SYSTEM OF RESEARCH AND TECHNOLOGICAL DEVELOPMENT

Figure 3

condition for the proportional growth and the maintaining of the dynamic equilibrium of the general cybernetic system, for reaching the *macroeconomic optim.*

Under the efficiency-profitableness system a severe comparison of the expenditures with the resulted outputs is achieved, starting up from the supreme criterion of the efficiency under the economic space: *the contribution of every activity to the growth of the national wealth and of the nation's welfare.*

The profitableness wears a multitude of forms depending on the component of the general cybernetic system under analysis and at end the efficiency of any activity is judged in the light of its contribution to the growth of the national wealth and of the nation's welfare. The efficiency-profitableness system certifies the profitableness of every activity under the national economy space, only in the extent this corresponds to a social need and lends to an actual increase of the national wealth and of the nation's welfare. In this direction, for the management of enterprises activity, the profitableness is used as an extremely important indicator, by the aid of which the quality of the whole developed activity is expressed, under the circumstances of permanent joining and correlating the criteria taken into account at enterprise level with those regarding the ensemble of the national economy.

A permanent flow of information exists between the efficiency-profitableness system and the system of management, command, checking, control. On their basis and in agreement with the objective laws of the society development, the macroeconomic decision body settles the fundamental coordinates of the ascendent evolution of the national economy system, the proportions on branches of the national economy, the policy of investments, in the foreign trade department, of research and technological engineering development, a.o.

The permanent increase of the economic efficiency represents an essential objective for the whole management activity of the social-economic life of the country. According to this objective law of developing the national economy system, the mobilization of all the nation's material and human resources takes place along the directions decisive for the society fast progress (Fig. 4).

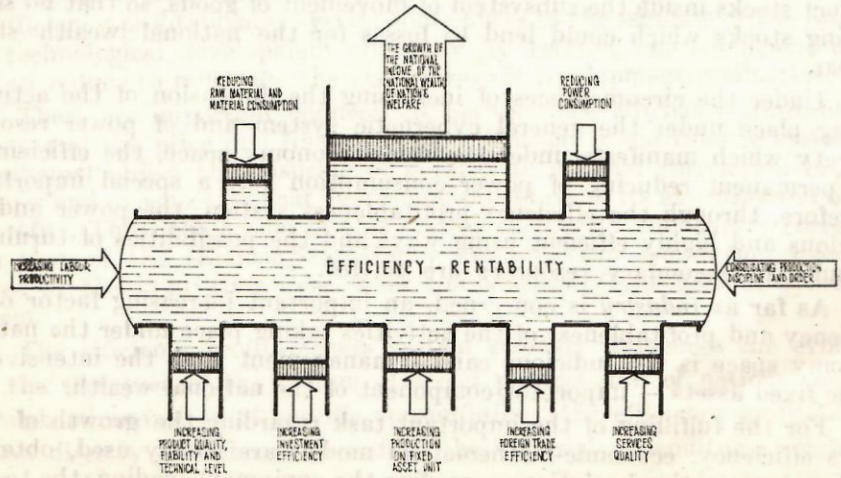

Figure 4

There is a strong symbiosis between the efficiency-profitableness system, that of the national wealth and that of goods production and services. The evolution of the general cybernetic system along the growth trajectories under the economic space needs ever growing quantities of raw materials, materials and power, for accelerately increasing the production and the labour productivity, for introducing modern technologies, for increasing the labour force qualification, for assuring reproductions on an enlarged scale at higher and higher levels. Therefore, the highest efficiently use of material and power resources, their superior turning to account represent an important factor of increasing the speed and the evolving acceleration under the national economy space, of reaching the development level of the economical advanced countries.

In the view of superior turning to account the material resources, the system of management, command, checking and control, connected to the efficiency-profitableness system, settles for every component of the goods production and services system a production structure, which should provide the increase of the weight of goods with a high degree of complexity and technicity, and of those with superior technical-economic parameters.

An important way of increasing the efficiency and the profitableness of every cell inside the goods production and services system is the rational use of all the circulating funds, the acceleration of their rotation speed. In this direction, the judicious standardization of raw material, material and semi-product stocks is of capital importance. Any over-dimensioning of stocks and blocking of normal flows of raw materials, materials and semi-products represents an actual "thrombosis" phenomenon for the economic body. Consequently, an analysis is carried out for the efficiency-profitableness system, regarding the level of raw material, material and semi-product stocks existing in every component of the goods production and services system and judicious standardization solutions for them are proposed, so that a normal flow of production should be assured. The efficiency-profitableness system has also to respond to the demands of determining the optimal value of finished product stocks inside the subsystem of movement of goods, so that no slowly moving stocks which could lend to losses for the national wealth should appear.

Under the circumstances of increasing the dimension of the activities taking place under the general cybernetic system and of power resources scarcety which manifests under the world economy space, the efficient use and permanent reducing of power consumption gets a special importance. Therefore, through the efficiency-profitableness system, the power and fuel judicious and highly efficient using ways and the possibilities of turning to account the secondary resources are settled.

As far as *industry* is concerned, an important increasing factor of the efficiency and profitableness of the activities taking place under the national economy space is the judicious careful management and the intensive use of the fixed assets — important component of the national wealth.

For the fulfilling of the important task regarding the growth of fixed assets efficiency, economic-mathematical models are widely used, obtaining on their basis optimal solutions regarding the equipment loading, the techno-

logical flows, the accomplishment in due time and of high quality of the thorough overhauls, a.o.

The permanent increase of the efficiency and of the profitableness of all the activities taking place in the *agriculture* subsystem and especially the highest efficiently use of the country lands, represents an essential condition for the optimal balanced and proportional growth under the national economy space. The rational use of lands, the preserving and increasing of its fertility, the intensive development of the agricultural production are essential components of the overall efficiency of the general cybernetic system of the national economy. For the efficiency-profitableness system an analysis is carried out regarding the use of agricultural lands and, on this basis solutions pertinent to the intensive use and at the same time to the preserving and increasing of the fertility of lands are proposed.

Between the efficiency-profitableness system and that of research and technological development there are strong interferences and connections. The whole complex process of permanent increasing the efficiency and the profitableness of activities taking place under the national economy space is potentated through the system of research and technological development. Through the solutions it proposes, this directly participates to increase the production and social labour productivity, to reduce the specific consumption, to raise the technical level and the product fiability, to use with high efficiency the production funds and the labour forces, to increase the investments efficiency, the foreign trade, a.s.o.

At the same time, the system of research and technological development is strongly influenced by the efficiency-profitableness system. By directing the system of research towards themes of major importance for the national economy, as the descovering and the turning to account of new power resources, the achievement of new materials subtitutes, the thinking out of new technologies, a.o., the efficiency-profitableness system directly contributes to increase the contribution of research activities to the fullfiling of social-economic development programmes of the country. At the same time, the efficiency-profitableness system contributes to the increase of the research and technological development efficiency by assuring the conditions necessary to reduce to minimum the cycle research-development-production.

There are important connections between the efficiency-profitableness system and the price and finance system. The price and finance system has as principal object the ensuring of a rational, optimal correlation between incomes and expenses, so that every unit should cover its expenses and obtain its profits. Thus, the action of this system is directly and hardly correlated with that of the efficiency-rentability system, their connection being reflected at the same time over other components of the general cybernetic system.

The efficiency-profitableness system strongly influences the evolution and the structure of the system of social product and of national income. Through minimization of specific consumptions, the efficiency-profitableness system directly contributes to reduce the material expenditures weight and consequently to increase the national income, the accumulation efficiency.

The efficiency-profitableness system ensures the maximum efficiency of the national fund of economic-social development of every monetary unit invested. Within the framework of the investment activity, one of the most important activities under the national economy space, the efficiency-profitableness system takes part at every stage, from the design and the selecting of sites up to their puting into operation, having the task of contributing to select the most efficient alternatives, of creating premises for diminishing the construction-mounting expeditures weight, of using highly efficient technologies, of adopting cheep constructive solutions which allow the shortening of the executing cycle, the launching in production at planned technical-economic due parameters.

Relying on the analysis carried out for the real necessities of every component of the general cybernetic system, for the way of using the existing capacities, for the possibilities of developing industrial platforms, for the competitivity on the world market of goods to be worked out, the efficiency-profitableness system furnishes to the management system the elements necessary for the substantiation of optimal alternatives for developing different economic branches or departaments.

The efficiency-profitableness system plays an extremely important part for *the control of flows formed between the national economy space and the world economy space.* The achieving of an increased efficacity of the foreign trade, the superior turning to account, on the world market, of the labour consumed under the general cybernetic system are essential conditions of an ascendent evolution under the national economy space.

Extremely complex interferences arise between the efficiency-profitableness system, on one side, and the system of national wealth and that of the nation's welfare, on the other side. All the activities taking place under the national economy space are analysed under the framework of the efficiency-profitableness system in the light of their contribution to the growth of the national wealth and of nation's welfare. At the same time, the dimension and the structure of the national wealth, of its components, are decisive elements of the increase of the overall efficiency of the general cybernetic system.

The cybernetic analysis carried out for the efficiency and profitableness system emphasizes the major part played by this in the complex activity of management and control of all the activities taking place under the national economy space, the important part played by it for the fulfilling of the economic-social development programmes.

2. CYBERNETIC-ECONOMIC MODELS

Together with the labour productivity system, the efficiency-profitableness system carries out the analysis of the efficiency of all activities taking place under the economic space and supplies to the management, command, checking and control system the elements necessary for the substantiation of optimal balanced and proportional growth solutions.

Within the framework of the efficiency-profitableness system, several specific cybernetic economic models are used — as substantiating tools for

the optimal alternatives of reducing the costs, the specific consumptions, the power and fuel consumption, and roughly speaking, the consumption of raw materials and materials. This allows the permanent increase of the production quality, the rational use of power sources, the judicious dimensioning of raw material, material and semi-product stocks, the acceleration of the rotation speed of circulating means, the efficient use of fixed assets, of all the production capacities, the optimization of investment funds, the increase of the profitableness of foreign trade activity, a.o. With the view of replying to a such wide range of tasks, a great variety of cybernetic-economic models are used, including *models of linear, nonlinear, stochastic programming, models of operative planning of production, of stock optimization*, a.o.

The mathematical-economic models for analysing the efficiency and the profitableness of activities taking place under the national economy space, which allow the *accurate quantifying of intensities of direct and feedback connections* formed between the systems and subsystems evolving under the national economy space, the knowledge of the way in which the propagating and the drawing effects act, display a particular importance for the analysis of economic efficiency of every activity, in the light of its contributions to the growth of the national wealth and of the people's welfare.

In analysing the efficiency of activities taking place under the national economy space, the efficiency-rentability system takes into account the feedback law, measuring as much the resource consumptions as the effects obtained under the overall national economy, respectively as much the direct effects as those drawn into other branches. As the development level of the economy increases, and its structure becomes more diverse, the difference between the effects, respectively the direct expenses and those implied through the propagation effect, may be important.

Thus, for example, the efficiency and profitableness growth in an enter prise for building technological equipment contributes, because of the feedback connection law, to the increase of the living standard of the population.

2.1. Models of input-output type

The models of input-output type proved to be of actual utility in quantifying the intensity of the feedback law action under the national economy space.

Therefore, the efficiency-profitableness system also comprises, among mathematical-economic models used by it, such types of models. This allows to carry out the analysis of a large range of indicators, characterizing the efficiency of the activities taking place under the national economy space. It must be mentioned that several macroeconomic indicators which have a particular importance in computing the efficiency and the rentability could have been determined only after the appearance of this model and after inishing the corresponding mathematical apparatus.

Most of the practical uses of the input-output approaches in the analysing and planning activity are generated from the extremely important mathematical proprieties of the Leontieff-Minkovski matrix which intervenes inside this model.

Starting from the matricial input-output model:

$$X = A \cdot X + Y$$

where A is the matrix of direct expenses (the Leontieff-Minkovski matrix), X is the production vector and Y the final consumption vector, then:

$$X = (E - A)^{-1} \cdot Y$$

As it was just underlined, the inverse of the technological matrix $(E - A)^{-1}$ plays an especially important part in all the uses of the input-output approach, in the analysing and planning activity. There was mathematically proved that its elements are those which *quantifies the intensity of the propagation phenomenon* through the branches of goods production, this fact resulting from the analysis carried out for the formulae:

$$(E - A)^{-1} = E + A + A^2 + A^3 + \ldots + A^n + \ldots$$

Henceforth, there will be emphasized the way of carrying out, on the basis of the inverse matrix elements $(E - A)^{-1}$, several indicators, with a high reflecting power, for efficiency analysis, indicators regarding the national economy expenditures of raw materials, materials, fuel, fixed assets and labour force, necessary for obtaining an unit of final product in each branch or subbranch.

Therefore, as the A_{ij} element of the matrix $(E - A)^{-1}$ regards the direct and averaged consumption, from the i branch production, for obtaining an unit of final product in the j branch, the rate:

$$\Gamma_j = \sum_{i=1}^{n} A_{ij}$$

quantifies the overall effort of the national economy for obtaining an unit of final consumption in the j branch.

The favourable influence of reducing the specific consumption in the j production branch over the indicator Γ_j, which quantifies the overall effort of the economy is emphasized by the following relationship:

$$\frac{\partial \Gamma_j}{\partial a_{jk}} = -\sum_{i=1}^{n} A_{ij} A_{kj}$$

The vector components:

$$\Gamma = (\Gamma_1, \Gamma_2, \Gamma_3, \ldots, \Gamma_n)$$

reflects in a synthetical form the necessary expenses, at national economy level, for an unit of final product output. For carrying out the analyses regarding the efficiency and profitableness, of a high interest is the branches classification depending on the indicators Γ_j and the identification on this basis, of the stocks for reducing the material and fuel consumption (Fig. 5).

Starting from the coefficients Γ_j one could prove the influence which the structure on branches of the final consumption has over the material expenditures in the social product.

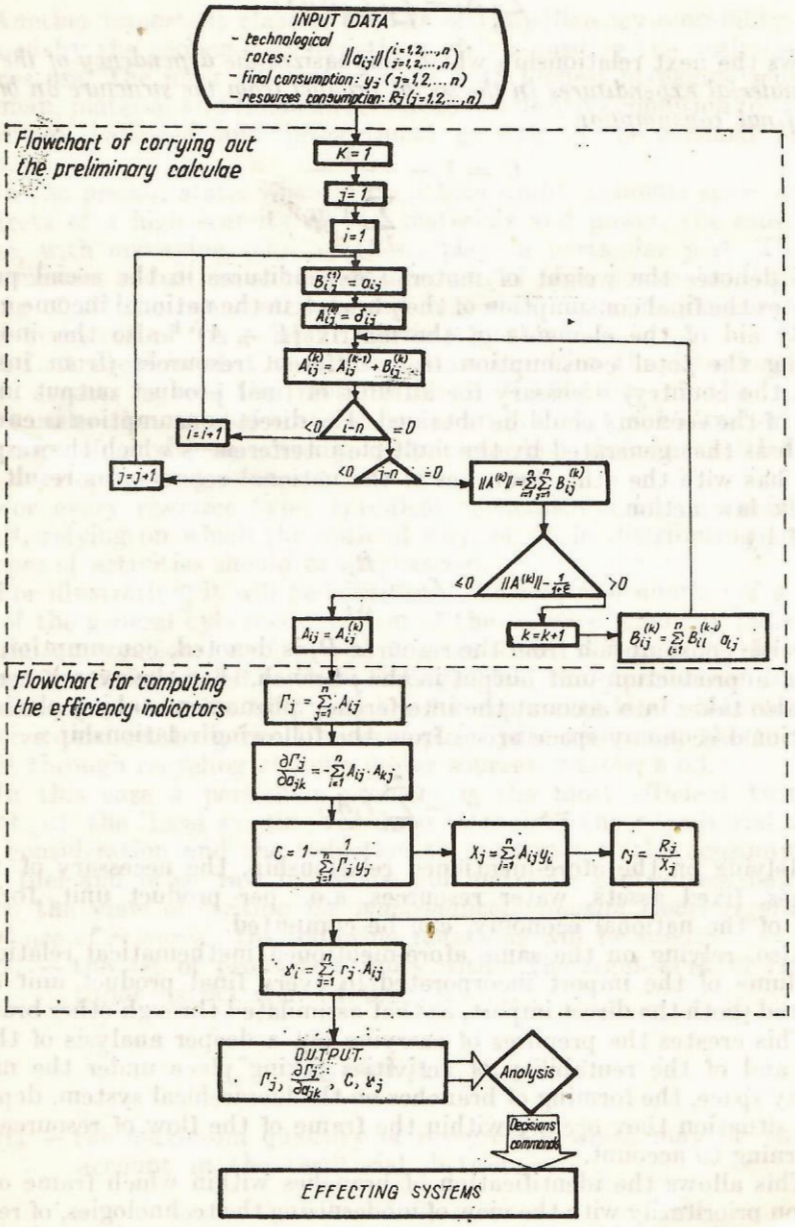
INPUT DATA
- technological rates: $\|a_{ij}\|_{(j=1,2,\dots,n)}^{(i=1,2,\dots,n)}$
- final consumption: y_j $(j=1,2,\dots n)$
- resources consumption: R_j $(j=1,2,\dots,n)$
Flowchart of carrying out the preliminary calculae
K = 1
j = 1
i = 1
$B_{ij}^{(1)} = a_{ij}$
$A_{ij}^{(k)} = d_{ij}$
$A_{ij}^{(k)} = A_{ij}^{(k-1)} + B_{ij}^{(k)}$
i - n
<0
=0
i = i+1
j - n
<0
=0
j = j+1
$\|A^{(k)}\| = \sum_{i=1}^{n}\sum_{j=1}^{n} B_{ij}^{(k)}$
$\|A^{(k)}\| - \frac{1}{1+\varepsilon}$
≤0
>0
$A_{ij} = A_{ij}^{(k)}$
k = k+1
$B_{ij}^{(k)} = \sum_{l=1}^{n} B_{il}^{(k-1)} a_{lj}$
Flowchart for computing the efficiency indicators
$\Gamma_j = \sum_{i=1}^{n} A_{ij}$
$\frac{\partial \Gamma_j}{\partial a_{jk}} = -\sum_{i=1}^{n} A_{ij} \cdot A_{kj}$
$C = 1 - \frac{1}{\sum_{j=1}^{n} \Gamma_j y_j}$
$X_j = \sum_{i=1}^{n} A_{ij} y_i$
$r_j = \frac{R_j}{X_j}$
$v_i = \sum_{j=1}^{n} \Gamma_j \cdot A_{ij}$
OUTPUT
$\Gamma_j, \frac{\partial \Gamma_j}{\partial a_{jk}}, C, v_j$
Analysis
Decisions commands
EFFECTING SYSTEMS

Figure 5

Indeed, from the relation:

$$\sum_{j=1}^{n} X_j = \sum_{j=1}^{n} \sum_{i=1}^{n} A_{ij} Y_j$$

it follows the next relationship which emphasizes *the dependency of the weight of the material expenditures in the social product from the structure on branches of the final consumption:*

$$C = 1 - \frac{1}{\sum_{j=1}^{n} \Gamma_j y_j}$$

C denotes the weight of material expenditures in the social product, y_j denotes the final consumption of the j branch in the national income volume.

By aid of the elements of the matrix $(E - A)^{-1}$ also the indicators reflecting the total consumption from different resources (from inside or outside the country) necessary for an unit of final product output in every branch of the economy could be obtained. The direct consumption is envolved, as much as that generated by the multiple interferences which the respective branch has with the other branches of the national economy as result of the feedback law action.

If by

$$r_j = \frac{R_j}{X_j}$$

the specific consumption from the resource R_j is denoted, consumption necessary for a production unit output in the j branch, then the overall necessary which also takes into account the interferency phenomena taking place under the national economy space arises from the following relationship:

$$\gamma_i = \sum_{j=1}^{n} r_j A_{ij}$$

Relying on the afore-mentioned relationship, the necessary of natura resources, fixed assets, water resources, a.o. per product unit, for every branch of the national economy, can be computed.

Also, relying on the same afore-mentioned mathematical relationships the volume of the import incorporated in every final product unit can be computed (both the direct import, as that assimilated through other branches).

This creates the premises of carrying out a deeper analysis of the efficiency and of the rentability of activities taking place under the national economy space, the forming of branches on the hierarchical system, depending on the situation they occupy within the frame of the flow of resources optimal turning to account.

This allows the identification of branches within which frame one has to action prioritarily with the view of modernizing the technologies, of reducing the specific consumption of raw materials, materials, of power and fuel. All this information is extremely useful for the solid substantiating of the economic policy decisions, of the economic growth programmes.

2.2. Economic-cybernetic models regarding the optimization of resources use

Another important class of models of the efficiency-rentability system is formed by the economic-cybernetic models regarding the optimization of resources use. The most efficient use and with highest managing sense of all the human, material and financial resources is a decisive condition for ensuring an optimal balanced and proportional growth of the national economy system.

In the present state, when in the whole world economic space one feels the effects of a high scarcity of raw materials and power, the most efficient use, with managing sense of these, plays a particular part. Therefore, the permanent reduction of the consumption of fuel, power and generally speaking of all the raw materials and materials, is a major care, at the level of every cell of the general cybernetic system.

A first problem that occurs in connection with the equational image of these aspects regards the most rational distribution of the resources existing under the national economy space on branches, subbranches, goods and groups of goods, on activity fields, according with the settled tasks of the developing programmes.

For every resource type, specifical economic-cybernetic models must be built, relying on which the optimal way of their distributing on fields and types of activities should be emphasized.

For illustration, it will be considered the case of a number of q components of the general cybernetic system of the national economy (enterprises, industrial corporations, a.o.) placed in s territorial districts. In the view of fulfilling the tasks settled to them through plan, the q production units, use a number of η resources from which a lot represents local resources of the respective territorial district (for example, hydro resources, the turning to account through recycling of some power sources, wastes, a.o.).

In this case a particular problem is the most efficient turning to account of the local existing resources in each of the s territorial districts under consideration and the reduction to minimum of the consumption of power, fuel and other raw materials and materials centralised distributed.

In the view of writing *the mathematical-economic model regarding the optimal use of resources*, the following notations will be used:

Q_α — the set of productive units within the framework of the territorial district $\alpha(\alpha = 1, 2, ..., s)$:

$$\sum_{\alpha=1}^{s} \operatorname{card} Q_\alpha = q;$$

R_α^k — the maximum quantity of resources k which may be turned to account in the territorial district α

$$k = 1, 2, ..., \eta$$
$$\alpha = 1\ 2, ..., s;$$

j — the number of assortments to be produced by the production units under consideration;

$\hat{X}^j$ — the quantity of the assortment j planned to be produced in the period under consideration;

x_{ij} the quantity of the assortment j which will be produced by the production unit i

$$i = 1, 2, ..., s_1$$

$$j = 1, 2, ..., J;$$

β_{ijk} — the specific consumption from the resource k for producing the assortment j by the production unit i

$$i = 1, 2, ..., s$$

$$j = 1, 2, ..., J$$

$$k = 1, 2, ..., \eta;$$

y_{ijk} the specific consumption from the resource k, obtained from the turning to account of the local reserves, for obtaining the product j from the production unit i

$$i = 1, 2, ..., s_1$$

$$j = 1, 2, ..., J$$

$$k = 1, 2, ..., \eta.$$

The economic-cybernetic model of which solution will emphasize the optimal way of turning to account the local resources and the minimization of the volume of power resources, of fuel, of raw materials and materials centralized distributed is:

$$\sum_{i=1}^{s} x_{ij} \geqslant \hat{X}^j \qquad j = 1, 2, ..., J$$

These J relationships provide for the fulfilment or even for the overfulfilment of the tasks regarding the necessary from the j assortments under consideration within the frame of the model.

$$x_{ij} \geqslant 0 \qquad i = 1, 2, ..., s_1; \quad j = 1, 2, ..., J$$

$$\sum_{i \in Q_\alpha} \sum_{j=1}^{J} y_{ijk} x_{ijk} \leqslant R_\alpha^k \qquad \alpha = 1, 2, ..., q; \quad k = 1, 2, ..., \eta$$

$$y_{ijk} \leqslant \beta_{ijk} \qquad i = 1, 2, ..., s_1; \quad j = 1, 2, ..., J; \quad k = 1, 2, ..., \eta$$

The afore-mentioned restrictions concern the turning to account of the resources existing in each of the s territorial districts, in which the production units under consideration are placed.

As by solving the economic-cybernetic model the object is the minimization of the consumption from all the resources and at the same time the as possible efficiently turning to account of the local resources the performance of the model will be as follows:

$$\sum_{i=1}^{s}\sum_{j=1}^{J}\sum_{k=1}^{\eta}(\beta_{ijk}-y_{ijk})x_{ijk}=min!$$

The built model is a model of quadratic programming; by its solving several useful elements are obtained regarding the way of turning to account the local resources existing in each territorial district, as well as the way of using those which are centralized distributed.

Within the frame of each territorial district the following quantities of each resource will be turned to account:

$$\hat{R}_{\alpha}^{k}=\sum_{i\in Q_{\alpha}}\sum_{j=1}^{J}y_{ijk}x_{ij} \qquad \begin{matrix}\alpha=1,2,...,q\\ k=1,2,...,\eta\end{matrix}$$

the production unit i having alloted the following quantities:

$$\hat{R}_{\alpha,i}^{k}=\sum_{j=1}^{J}y_{ijk}x_{ij} \qquad \begin{matrix}i\in Q_{\alpha}\\ \alpha=1,2,...,q\\ k=1,2,...,\eta\end{matrix}$$

The quantity of the resource k which will be alloted to the district α from the centralized fund, in the view of fulfilling the planned production tasks is:

$$H^{k}=\sum_{i\in Q_{\alpha}}\sum_{j=1}^{J}\sum_{k=1}^{\eta}\gamma_{ijk}x_{ijk} \qquad \begin{matrix}\alpha=1,2,...,q\\ k=1,2,...,\eta\end{matrix}$$

where:

$$\gamma_{ijk}=\beta_{ijk}-y_{ijk}$$

By solving the built economic-cybernetic model the object is the *minimization* of the quantities H_{α}^{k}, therefore:

$$\sum_{\alpha=1}^{q}\sum_{k=1}^{\eta}H_{\alpha}^{k}=min.$$

The optimization may be achieved, on one side, by reducing the consumption, and on the other side, by as possible higher turning to account of the local resources.

By analysing the dual variables, attached to the afore-mentioned economic cybernetic system, extremely useful information regarding the way of turning to account the resources, as well as the possibilities set up for overfulfilling the settled tasks may be obtained.

Another problem which appears, connected to the reducing of specific consumptions, concerns the reducing to minimum of wastes.

For example, in case of enterprises which consume metal under the form of sheets or bars, the mathematical *programming models allow to determine the optimal way of cutting*, so as to reduce to minimum the wastes volume.

For writing the model, the following notations will be used:

n — the number of marks necessary for the enterprise;

m — the number of possible alternatives of cutting the available metal (sheets, bars, a.s.o.);

a_i — the volume of marks of type i necessary for the production process;

t_{ij} — the number of marks of type i obtained in the alternative j for cutting the metal;

d_j — the volume of wastes obtained in the alternative j for cutting the metal.

Denoting by x_j the quantity of metal that will be cut according to the alternative j, these unknowns have to satisfy the next relationships:

$$\sum_{j=1}^{m} t_{ij} x_j \geq a_i \qquad x_j \geq 0; \quad x_j \in N$$

$$\sum_{j=1}^{m} d_j x_j = min!$$

By solving the afore-mentioned model, the quantity of metal (sheets, bars, a.s.o.) which has to be cut according to each alternative, so as to provide the necessary number of marks for the production process and at the same time to reduce to minimum the wastes, is determined.

2.3. Economic-mathematical model for optimal use of the production capacities

An extremely important problem for ensuring the permanent growth of the economic efficiency under the national economy space is the optimal use of fixed assets, of all the production capacities. It has been proved, in this field, that the economic-cybernetic modelling is of real utility in emphasizing the reserves for the production growth per fixed assets unit. It will be supposed, for exemplification, the case of an enterprise which has at its disposal m types of process lines or equipments, on which n assortments may be output. At the same time, it will be supposed that the achieved hour productivities of equipments and the specific consumptions depend on the process line and on the type of the manufactured product.

In writing the mathematical model the following notations will be used:

a_j — the quantity of the assortment j which has to be produced in the period under consideration (tons);

D_i — the production capacity of the process line i (in hours);

C_k — the maximum quantity of the resource k which may be used ($k = 1, 2, ..., K$);

p_{ij} — the hour productivity of the process line i for the assortment j (tons/hour);

α_{ij}^k — the specific consumption from the resource k for obtaining the assortment j in case that this is processed on the process line i;

I_j — the process lines on which the assortment j may be processed;

J_i — the assortments possibly to process on the process line i.

The problem to be solved concerns the distributing of the assortments which should be processed on every process line, so as to ensure on optimal loading of equipments.

For building the economic-cybernetic model the following variables will be introduced:

x_{ij} — the number of hours in which the process line i will process the assortment j.

The mathematical model, the solving of which gives the production plan which assures for the optimal loading of equipments is:

— restrictions regarding the fulfilling of production tasks:

$$\sum_{i \in Ij} p_{ij} x_{ij} \geqslant a_j \qquad j = 1, 2, ..., n;$$

— restrictions regarding the existing production capacities:

$$\sum_{j \in Ji} x_{ij} \leqslant D_i \qquad i = 1, 2, ..., m;$$

— restrictions regarding the resource consumptions:

$$\sum_i \sum_j \alpha_{ij}^k p_{ij} x_{ij} \leqslant C_k \qquad k = 1, 2, ..., K;$$

— restrictions regarding the fulfilment of the settled indicators:

$$\sum_i \lambda_j^h p_{ij} \cdot x_{ij} \geqslant \lambda_h \qquad h = 1, 2, ..., H;$$

— restrictions regarding the nonnegativity of variables:

$$x_{ij} \geqslant 0.$$

The model performance-function, which provides the maximum loading of equipments, will be:

$$\sum_i \sum_j x_{ij} = max!$$

In case the production maximization is in view, value expressed, the performance-function grows:

$$\sum_i \sum_j q_j \cdot p_{ij} \cdot x_{ij} = max!$$

where q_j is the price of the assortment j.

By using the solving algorithms of the mathematical programming models, especially useful elements are obtained, for ensuring the fulfilment of the settled tasks and at the same time for the highest using of fixed assets, of all the existing production capacities.

2.4. Economic-cybernetic models of optimizing investment efficienc

One of the most important aspects of the overall efficiency under th national economy space referes to the highest efficiently use of the developin national fund, to the use with managing sense of every invested monetar unit.

Within the efficiency-rentability system numerous types of economic cybernetic models are used, playing the part of emphasizing the optima way of using the investment funds allotted for developing the branches an subbranches of the national economy (Fig. 6).

Among the multiple aspects arised from the judicious use of the invest ment funds, alloted for the national economy development also are tha regarding the placing and the dimensioning of the new industrial projects as well as the way of modernizing and developing those already existing

For illustrating such a type of economic-cybernetic model the cas will suppose in which, for satisfying the permanent increasing necessitie of the national economy, a certain investment fund is allocated for the deve lopment of an industrial sector. The problem which arises referes to the optima use of the assigned investment fund, taking into account the possible site for the new projects to be built, the technological alternatives that ma be adopted, the possibilities of developing and modernizing the existin centres, the specific investments corresponding to each alternative, a.o.

The elements from which the model starts, settled through the carrie out technical-economic studies, are:

— the sites in which the new projects may be placed, the technologica alternatives that could be adopted and the maximum designed capacities

— the maximum capacities with which the existing central corporation could develop;

— the geographical positions of the raw materials bases and of th end users;

— the approved investment fund for developing the sector;

— the specific investment and the previsional calculated costs per tinent to every development project.

In writing the mathematical-economic model the following notation will be used:

m_1 — the number of sites in which the new projects may be placed These will be denoted through the index i

$$(i = 1, 2, ..., m_1);$$

m_2 — the number of existing production centres inside the sector These will be denoted through the index j

$$(j = m_1 + 1, m_1 + 2, ..., m_1 + m_2),\ m = m_1 + m_2;$$

p_i — the number of existing design alternatives for the site $i(i = 1, 2, ..., m_1)$. These refere to the capacities possible to adopt, to th technology types, a.o.;

r — the number of new projects, approved to be built;

n — the number of end users. These will be denoted by the inde $q(q = 1, 2, ..., n)$;

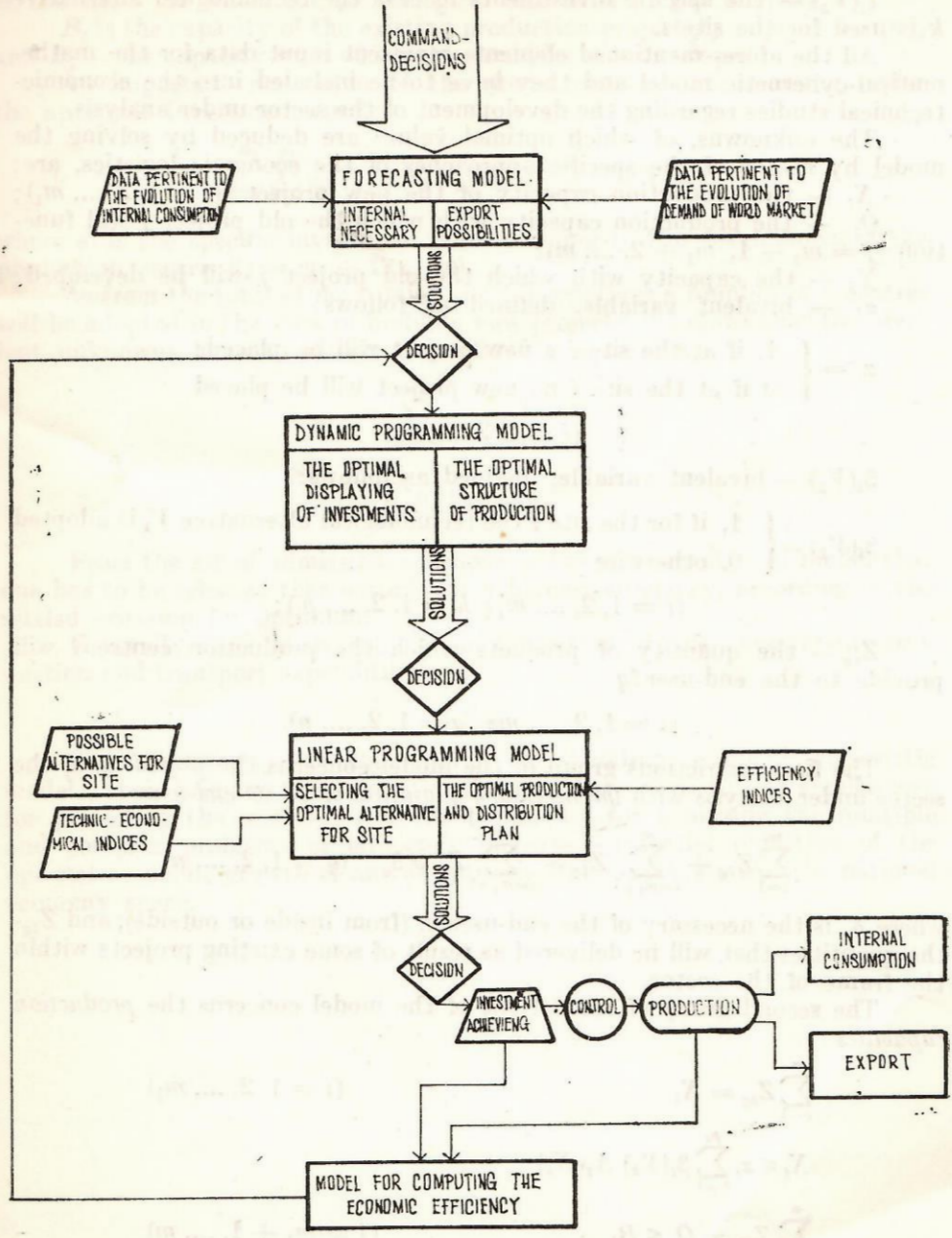
COMMAND-DECISIONS
DATA PERTINENT TO THE EVOLUTION OF INTERNAL CONSUMPTION
FORECASTING MODEL
INTERNAL NECESSARY
EXPORT POSSIBILITIES
DATA PERTINENT TO THE EVOLUTION OF DEMAND OF WORLD MARKET
SOLUTIONS
DECISION
DYNAMIC PROGRAMMING MODEL
THE OPTIMAL DISPLAYING OF INVESTMENTS
THE OPTIMAL STRUCTURE OF PRODUCTION
SOLUTIONS
DECISION
POSSIBLE ALTERNATIVES FOR SITE
TECHNIC-ECONOMICAL INDICES
LINEAR PROGRAMMING MODEL
SELECTING THE OPTIMAL ALTERNATIVE FOR SITE
THE OPTIMAL PRODUCTION AND DISTRIBUTION PLAN
EFFICIENCY INDICES
SOLUTIONS
DECISION
INVESTMENT ACHIEVING
CONTROL
PRODUCTION
INTERNAL CONSUMPTION
EXPORT
MODEL FOR COMPUTING THE ECONOMIC EFFICIENCY

Figure 6

$e_i(V_k)$ — the specific investments in case the technological alternative k is used for the site i.

All the afore- mentioned elements represent input data for the mathematical-cybernetic model and they have to be included into the economic-technical studies regarding the development of the sector under analysis.

The unknowns, of which optimal values are deduced by solving the model by means of the specific approaches of the economic logistics, are:

X_i — the production capacity of the new project $i (i = 1, 2, ..., m_1)$;

Q_j — the production capacity with which the old project j will function $(j = m_1 + 1, m_1 + 2, ..., m)$;

Y_j — the capacity with which the old project j will be developed;

α_i — bivalent variable, defined as follows:

$$\alpha_i = \begin{cases} 1, \text{ if at the site } i \text{ a new project will be placed;} \\ 0 \text{ if at the site } i \text{ no new project will be placed} \end{cases}$$

$$(i = 1, 2, ..., m_1)$$

$\beta_i(V_k)$ — bivalent variable, defined as follows:

$$\beta_i(V_k) = \begin{cases} 1, \text{ if for the site } i \text{ the technological alternative } V_k \text{ is adopted} \\ 0, \text{ otherwise} \end{cases}$$

$$(i = 1, 2, ..., m_1;\ k = 1, 2, ..., p_i);$$

Z_{iq} — the quantity of products which the production centre i will provide to the end-user fq

$$(i = 1, 2, ..., m;\ q = 1, 2, ..., n).$$

The first restrictions group of the model concerns the *providing* of the sector under analysis with *the necessary quantities of all its end-users*;

$$\sum_{i=1}^{m_1} Z_{iq} + \sum_{i=m_1+1}^{m} Z_{iq} + \sum_{i=m_1+1}^{m} Z'_{iq} \geqslant \delta_q;\ (q = 1, 2, ..., n)$$

where δ_q is the necessary of the end-user q, (from inside or outside), and Z_{iq} - the quantities that will be delivered as result of some existing projects within the frame of the sector.

The second group of restrictions of the model concerns the *production capacities:*

$$\sum_{q=1}^{n} Z_{iq} = X_i \qquad (i = 1, 2, ..., m_1)$$

$$X_i \leqslant \alpha_i \sum_{k=1}^{p_i} \beta_i(V_k)\, A_i(X_k)$$

$$\sum_{q=1}^{n} Z_{jk} = Q_j \leqslant B_j \qquad (j = m_1 + 1, ..., m)$$

$$\sum_{j=1}^{n} Z'_{jq} = Y_j \leqslant B'_j$$

where $A_i(V_k)$ is the production capacity of the new project that will be placed at the site i for which the technological alternative V_k is adopted.

B_j is the capacity of the existing production project $j(j = m_1 + 1,...,m)$, and B'_j — the capacity with which this could be still developed.

An important restriction of the model concerns the framing under the approved investment fund:

$$\sum_{i=1}^{m_1} \sum_{k=1}^{p_i} e_i(V_k)\, \alpha_i \beta_i(V_k)\, X_i + \sum_{j=m_1+1}^{m} e_j Y_j \leqslant I$$

where e is the specific investment corresponding to the development of the production centre $j(j = m_1 + 1, ..., m)$.

As from the total of m_1 studied sites alternatives a number of r centres will be adopted in the view of building new projects, it follows that the bivalent unknowns have to satisfy the following equations:

$$\sum_{i=1}^{m_1} \alpha_i = r$$

$$\sum_{k=1}^{p_i} \beta_i(V_k) = \alpha_i$$

From the set of admissible solutions of the afore-mentioned model that one has to be selected that ensures for a highest efficiency, according to the settled criterion for optimum.

Generally, this referes to the minimization of the investment, production and transport expenditures.

* * *

The amplification of the activity of building economic-cybernetic models, their bringing into operational stage, have a particular significance for perfecting the methods and the techniques for analysing the multiple and complex problems of efficiency increase — essential objective of the optimal economic growth of all the activities taking place under the national economy space.