POLSKA AKADEMIA NAUK
INSTYTUT BADAŃ SYSTEMOWYCH

PROCEEDINGS OF THE 3rd ITALIAN-POLISH CONFERENCE ON APPLICATIONS OF SYSTEMS THEORY TO ECONOMY, MANAGEMENT AND TECHNOLOGY

WARSZAWA 1977

Redaktor techniczny
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AN INTERACTIVE SYSTEM FOR MANAGEMENT AND CONTROL IN A MULTIPROJECT COMPANY

The system illustrated below provides the management staff with the appropriate instruments for:

— keeping under constant control the production situation of the Company;

— managing effectively the available resources;

— foreseeing the global economic results of the Company in reference to the current working load;

— testing what are, in terms of economic results, the possible effects of alternative hypotheses in reference to the works in progress; and locating the possible market areas for the Company to intervene.

The Company for which the system has been realized is so characterized:

— it produces software,

— it works on jobs.

Software production — what is now meant by this term — is similar to the production of any project company whose main object is to supply ideas.

The man/time necessary to the realization of a project represents the main portion of the costs of production. And this, along with a particular type of demands on the market, does not allow to have:

— times of production which can be standardized (as it is the case of industrial manufacturing);

— sales which can be programmed at short or medium term (as it is the case of mass products);

Working on jobs allows to deal with each supply as an independant work. In charge of the supply is a project-chief who is fully responsible for the budget of the job. When the nature of a supply (firm organization, production planning, restructuring of the distribution network or of the transport network) justifies it, the budget of a job can vary substantially.

The variation can be due to different factors, such as the enlargement of the dimensions of a work, a change in the supply, a slowing-down of the production because of unforeseen problems, etc.

For what has been previously said it is clear the necessity of being equipped with an instrument (and with an adequate information basis) which is able to follow the proceeding of the different jobs, and to provide the management

with constant up-to-date data referring to the situation both in terms of estimate and of balance.

On the basis of the proceeding of the operations, it is possible to foresee the economic results of the company.

It is also useful to the decider in terms of:

— anomalous developments of the working load,

— new inputs of the market,

— alternative policies in the management of the resources or in marketing,

— others,

to have at his disposal an instrument which, through a verification of the consequences of different hypotheses on the final economic result, can help him to make the best choice for the company.

The possibility of consulting the system through interactive terminals reduces the response time and improves the effectiveness of the realization.

The system supplied by TEMA is divided into two connected parts:

— an information system for the analysis of a single job and for the management of the available resources;

— an instrument for the forecast of the economic results of the company.

INFORMATION SYSTEM

The main object of the information system are:

— to allow the project chief to check conveniently on the proceeding of the job, through a balance of costs and proceeds;

— to facilitate the revision and the bringing up-to-date of the budget of the job;

— to improve the management of the available resources on the basis of the working loads.

Every month the system provides the project-chiefs with a prospect of the proceeds entry and cost entries. The cost entries are subdivided according to man/hour and out-of-pocket costs (material, missions, use of the computer, etc.).

The prospect includes:

— all the budget data previously formulated (global budget, current financial year budget, future financial years budgets, monthly budget for the quarter to come) and

— all the balance data (balance in progress, previous financial year balance, current financial year balance and the last month balance).

All balances are automatically determined by the computer through the elaboration of:

— data related to the man/time employed; these data are provided by the employees and refer to the number of hours each employee has been working in a job;

— the balance of the out-of-pocket costs and the invoices, directly derived from the industrial book-keeping.

The output provided by the system allows the project-chief to control how the work proceeds, through a checking of the estimate compared with the state of the balance of the job.

Through this analysis, the project-chief is enabled to evaluate whether his job is normally evolving or a change in budget is necessary.

All changes made on the estimate will be included in the information system which will elaborate the new budget for the project chief.

A more synthetic copy of this budget will be also given to the management staff so as to enable them to control the way all the jobs of the company proceed.

The estimates provided by the project-chief are:

— with a horizon for the whole duration of a work;

— with an annual horizon;

— with a quarterly horizon, monthly splitted.

The first one enables the Management to evaluate, at the opening of the job the estimated final balance and the amount of personnel which is necessary for its realization.

The second one provides the Management with the data which are necessary, in the second part of the system, to elaborate automatically the estimated annual economic result of the company.

The monthly estimates concern a rather short and close period of time, and provide the Management with more reliable and precise estimates. They are to be used in short term managements of the available resources. In particular, the cost entry referring to the foreseen hour/load for the following quarter (an entry which in the case of a company like the one under examination must be very carefully taken into consideration) must be provided by each of the project-chiefs, as it is subdivided among the employees working at the job.

All these data are finally elaborated by the information system which provides the Management with a monthly output of the total hour/load as it has been subdivided among the different jobs and assigned to each employee. The monthly output indicates also the available hours. Through the analysis of this project the Management is enabled to verify the resources which are still available and to manage them appropriately.

This information system, in the company where it has been used, has allowed:

— a remarkable time saving on the part of the project-chief in terms of controlling of all the proceeds of a job through an automatic elaboration of the balances;

— a more accurate analysis of the proceeding of each job both of the project chief and by the Management;

— a facilitation in the revision of the budgets and consequently more precise and reliable estimates;

— a more immediate identification of the available resources and a consequent better management of the personnel;

— a more effective and frequent control of the jobs on the part of the Management;

— a more reliable availability of the data, both in terms of estimate and of balance, in view of the global economic result of the company.

INSTRUMENT FOR THE ESTIMATE OF THE ECONOMIC RESULTS OF THE COMPANY

Given the nature of the Company, the products can be directly related to the "hours of work" The number of "hours of work" for each job represents a fundamental parameter for the evaluation of the costs.

The kinds of works which are feasible and the consequent classification of the hours are shown in scheme no. 1. The time of reference is the year. The costs referred to one financial year are shown in scheme no. 2. In particular, the costs C_p and C_s are referred to the marketable hours following two different criteria depending whether one is dealing with the number of hours related to jobs managed in the office (C) or with hours related to employees detached for a long period of time in the office of a client. In scheme no. 3 an example of costing is given and a standard cost per hour for services performed in the office is outlined.

In dealing with this problem, the personnel hours have been considered homogenously in terms of quality-level of the service. (The introduction of different levels of service, when it is necessary, does not create any problem from a logical viewpoint.

Proceeds, costs and profits for all the jobs of the Company are here estimated, and distinctions are made for the various cases, holding in due consideration the following assumptions:

1) for those offer jobs which are not foreseen to be closed within the year, proceeds on a par to the costs borne during the year are assumed.

2) for those jobs which are related to the preparation of products for subsequent sale, proceeds on a par to the costs borne during the year are assumed.

Since the objective is the set-up of an instrument allowing the estimate of an economic result, we examine here those groups of orders which can be a source of profit or a cause of loss within the year.

They are:

a — sale jobs closed within the year

b — sale job not closed within the year

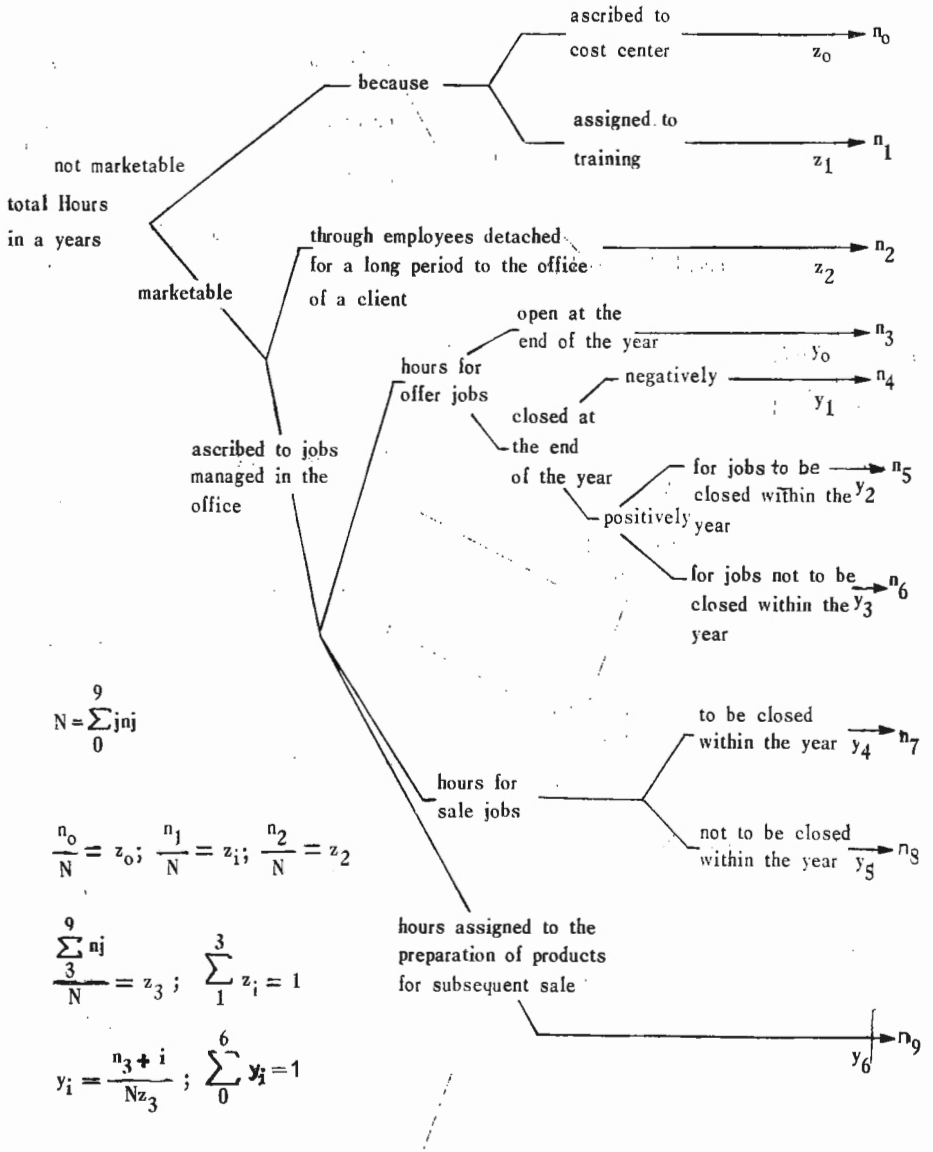
c — offer job with negative results, worked at and closed within the year

d — jobs referring to the detachment of the personnel.

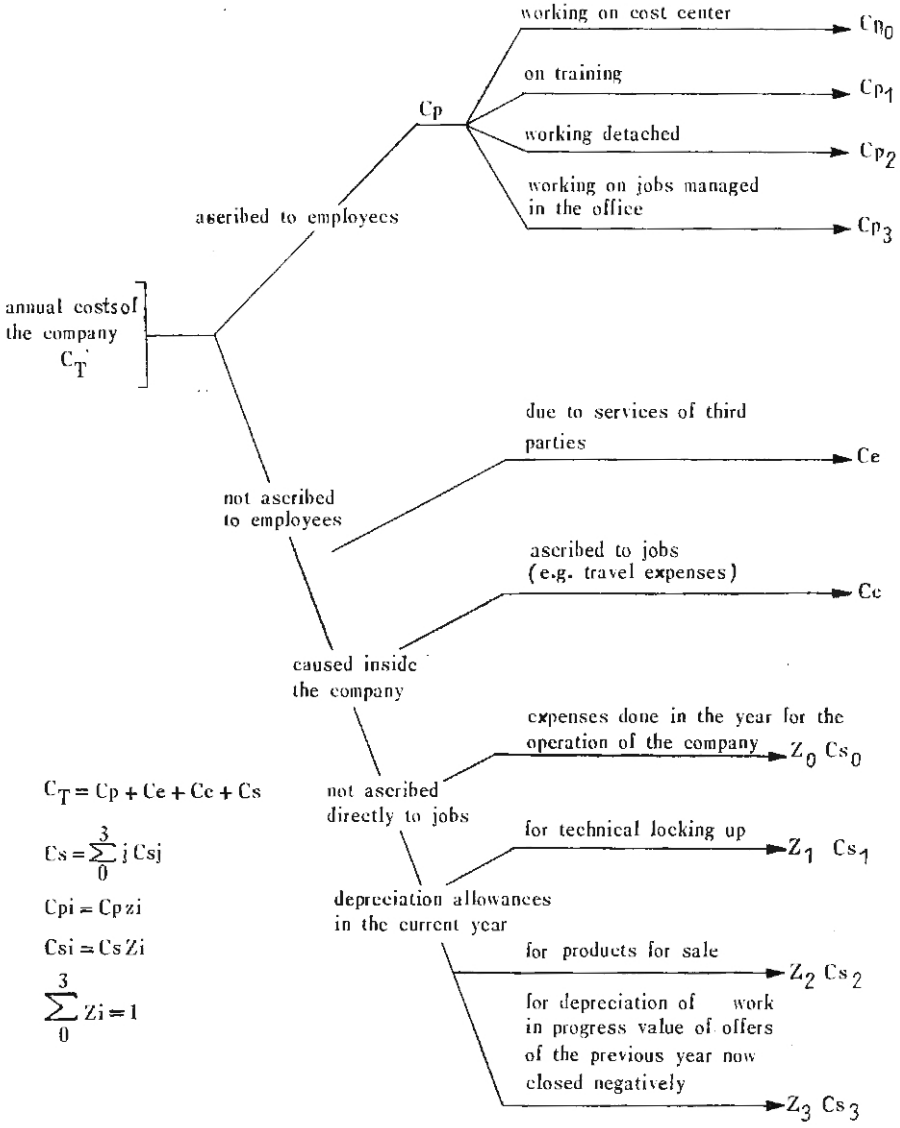
The evaluation and the proceeds of the sale jobs is based on the concepts and formulas illustrated in scheme no. 4 (and 4 bis).

The economic result of one eyar is estimated as in scheme no. 5.

SCHEME No. 1


total Hours in a years
not marketable
because
ascribed to cost center
z_0
n_0
assigned to training
z_1
n_1
marketable
through employees detached for a long period to the office of a client
z_2
n_2
ascribed to jobs managed in the office
hours for offer jobs
open at the end of the year
y_0
n_3
closed at the end of the year
negatively
y_1
n_4
positively
for jobs to be closed within the year
y_2
n_5
for jobs not to be closed within the year
y_3
n_6
hours for sale jobs
to be closed within the year
y_4
n_7
not to be closed within the year
y_5
n_8
hours assigned to the preparation of products for subsequent sale
y_6
n_9
$N = \sum_0^9 jnj$
$\frac{n_0}{N} = z_0; \frac{n_1}{N} = z_i; \frac{n_2}{N} = z_2$
$\frac{\sum_3^9 nj}{N} = z_3; \sum_1^3 z_i = 1$
$y_i = \frac{n_3 + i}{Nz_3}; \sum_0^6 y_i = 1$

SCHEME No. 2



$$C_T = Cp + Ce + Cc + Cs$$

$$Cs = \sum_{0}^{3} j\,Csj$$

$$Cpi = Cp\,zi$$

$$Csi = Cs\,Zi$$

$$\sum_{0}^{3} Zi = 1$$

SCHEME No. 3

$$Cv = \sum_{0}^{3}{}_{i} \alpha_i Cp_i + \sum_{0}^{3} \beta_i Cs_i$$

$$= Cp \sum_{0}^{3}{}_{i} \alpha_i \chi_i + C_s \sum_{0}^{3}{}_{i} \beta_i Z_i$$

$$Cd = \sum_{0}^{3}{}_{i} (1-\alpha_i) Cp_i + \sum_{0}^{3}{}_{i} (1-\beta_i) C_{si}$$

$$= Cp \sum_{0}^{3}{}_{i} (1-\alpha_i) \chi_i + C_s \sum_{0\,i}^{3} (1-\beta_i) Z_i$$

where α_i for $i = 0 \ldots 3 \equiv (\alpha_0, \alpha_1, 0, 1)$

β_i for $i = 0 \ldots 3 \equiv (\beta_0, 1, \beta_2, \beta_3)$

$$\sigma = \frac{Cp}{N\chi_3} \sum_{0\;\;i}^{3} \alpha_i \chi_i + \frac{Cs}{N\chi_3} \sum_{0\;\;i}^{3} \beta_i Z_i$$

SCHEME No. 4

C_{ci} = fraction of costs C_c to be ascribed, as yearly mean, to jobs characterized by parameter y_i

△ mean parameter w_i is introduced so that:

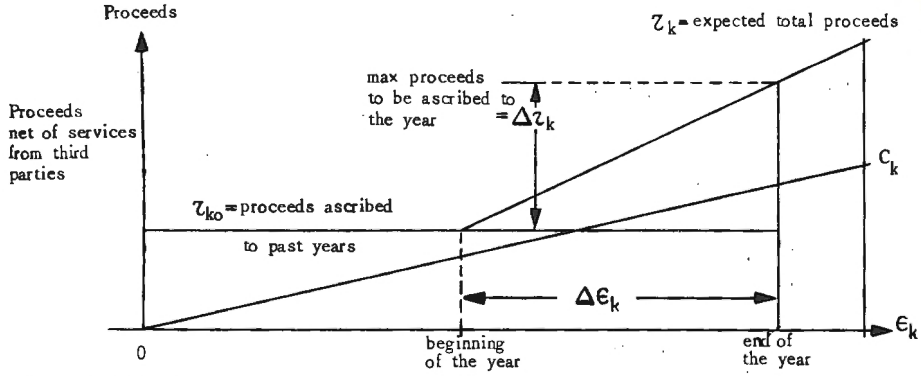
$$C_{ci} = C_c w_i; \quad \sum_{0}^{6} w_i = 1; \quad i = 0 \ldots 6$$

Total Costs (excluding services of third parties) ascribed to jobs characterized by parameter y_i:

$$N\sigma x_3 y_i + C_c w_i$$

Degree of progress ϵ_k of the k sale job:

$$\epsilon_k = \frac{\text{costs due to the } k \text{ job at time } t}{\text{total costs } C_k \text{ due to the } k \text{ job}}$$



SCHEME No 4 bis

Profit, referred to year, from sale jobs not closed in the year:

$$\sum_{1}^{k} \Delta\epsilon_k \left(\frac{\tau_k - \tau_{ko}}{1-\epsilon_{ko}} - C_k \right) \psi_k$$

where ψ_k is a "precautionary" coefficient $\leqslant 1$
if the profit from the k job is positive;
$\psi = 1$ if the profit of the job is negative.
Profit, to be ascribed to the year, owing to employees detaching:

$$R_d - C_p \sum_{0}^{3} i(1-\alpha i) zi - C_s \sum_{0}^{3} i(1-\beta_i) Zi$$

where R_d are the proceeds, ascribed to the year, owing to employees detaching.

SCHEME No 5

The economic result is given by:
$-$ Loss from offer jobs with negative results, worked at and closed within the year
$+$ Profit from sale jobs closed within the year:

$$-N\sigma z_3 y_1 - C_c w_1$$

$+$ Profit from sale jobs not closed within the year

$$+R - N\sigma z_3 (y_2 + y_4) - C_c (w_2 + w_4)$$

$+$ Profit from employees detaching

SUMMARY

The system has been implemented in an engineer-contractor company which assigns project responsibilities to individual managers.

The interacting components of the system are an informational service and an instrument for the processing of company budgets.

Main objectives of the informational service are:

— to permit the project manager to suitably control job progress through continuous cost and income accounting:

— facilitate revising and updating project budgets:

— to improve management of available resources on basis of work loads.

Objectives of the instrument for budget processing are the probiding of balances and estimates of financial results and above all for conducting rapid tests of the financial results which might be had under hypothetical alternate methods of performing the work.

Interrogating and updating are achieved through use of an interactive computer terminal which considerably increases efficiency of the system.

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