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Cybernetic Modelling of the Quality of Services with Applications to the Postal System

The author, placing the postal system in the area of tertiary services, treats it as a "very big" cybernetic system, accepting the idea that a system may be described only as a kind of statistics.

The work presents the theoretical premises of the method for the delimitation and quantisization of the entropic state of the postal system services, considering the evolving in time of a finite probability field, consisting of two elementary events, thus defining the alternative characteristic feature of these services' quality.

The author, using a system of reference, in conformity with the specific of the postal services, sets up their general system in sub systems, each of them being dealt with an independent systems, establishing the quality indexes and the ready reckoner, by static and mathematical methods.

The work puts at the disposal of the specialists belonging to the postal branch, immediate practical methods for the quantisization, following up and analysis of the efficiency of the effected services, as well as the appreciation of the organizational degree, or the efficiency of their functioning, compared to a previously established standard for the Main Post Office of Bucharest.

For over 20 years the service department, respectively the tertiary department, has been holding an ever more important share in the national economies of states, both in the national income and within the active population. The party's programme having set the task of "developing public services both in towns and villages, of satisfying the most diverse requirements of a modern civilized life", it results for our country too that the tertiary will mark a continuous development.

We are not referring to the tertiary department in the underdeveloped and some developing countries where it represents a market for the employ-

ment of the active population which cannot be absorbed by the directly productive departments. This, in order to correctly understand, in the context of the contemporary technical and scientific revolution, the content of the tertiary department and because many authors consider the development of services an as economic revolution in the post-war period.

The confrontations of opinions on the content and delimitation of the tertiary are not the object of this thesis. However, it is interesting to note the quasi consensus of the authors of specialist's literature on the remark that the productivity and quality of services in the period after 1970 may be considered a new economic revolution.

An economic domain with many supporters, but, with many disputants as well, the tertiary has long been acquainted with cybernetics. In the consulting field, marketing, informatics, management, scheduling, etc., the systemic study, the computers and the concepts of cybernetics are used currently.

"The cybernetic modelling of the quality of services" comes with elements of originality, tackling the quality of services as a cybernetic system with all consequences resulting thereof: the adequate interpretation of the notion of a pattern, the establishment of the modalities of control and adjustment for the cybernetic system of quality and the establishment of the possibilities of cybernetic modelling for the quantisization of the quality of services.

By introducing the utilization of cybernetics into this domain of the tertiary, our study starts from the following premises:

— the revolution of the quality of services is an ascertained fact and a sharp necessity, at present;

— the control of quality (especially in industry) is a well adjusted domain as regards the methods and techniques of establishing their indices and values for the quality of products and operations. We are not in the same situation when we want to elaborate a global estimation of the quality obtained for a group of products or operations, or of the quality obtained by a group of diversified production (workshop, section, enterprise, branch);

— if we regard quality from the point of view of utility for users, we think that the problem of establishing a total estimation of the quality is putting in the same way both in industry and in the tertiary activities. Especially if we consider also the share of the tertiary in industry;

— the subject of our study was, however, confined to the service department considering the author's sphere of preoccupations and the possibility of proving the validity of modelling established for the postal Department of Bucharest municipality, the service unit, managed by the author;

— the necessity of applying the results of this study consists in the public access to the services of the tertiary and in the fact that the worsening of the quality of one of these services entails chain deteriorations in the quality of the others, attempting upon the living and even health of the population and upon the harmonious evolution of social life.

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The study also starts from the premise that the notions of complexity and reliability of a cybernetic system can be presented not only qualitatively (plates 1 and 2) but also quantitatively, the complexity being proportional

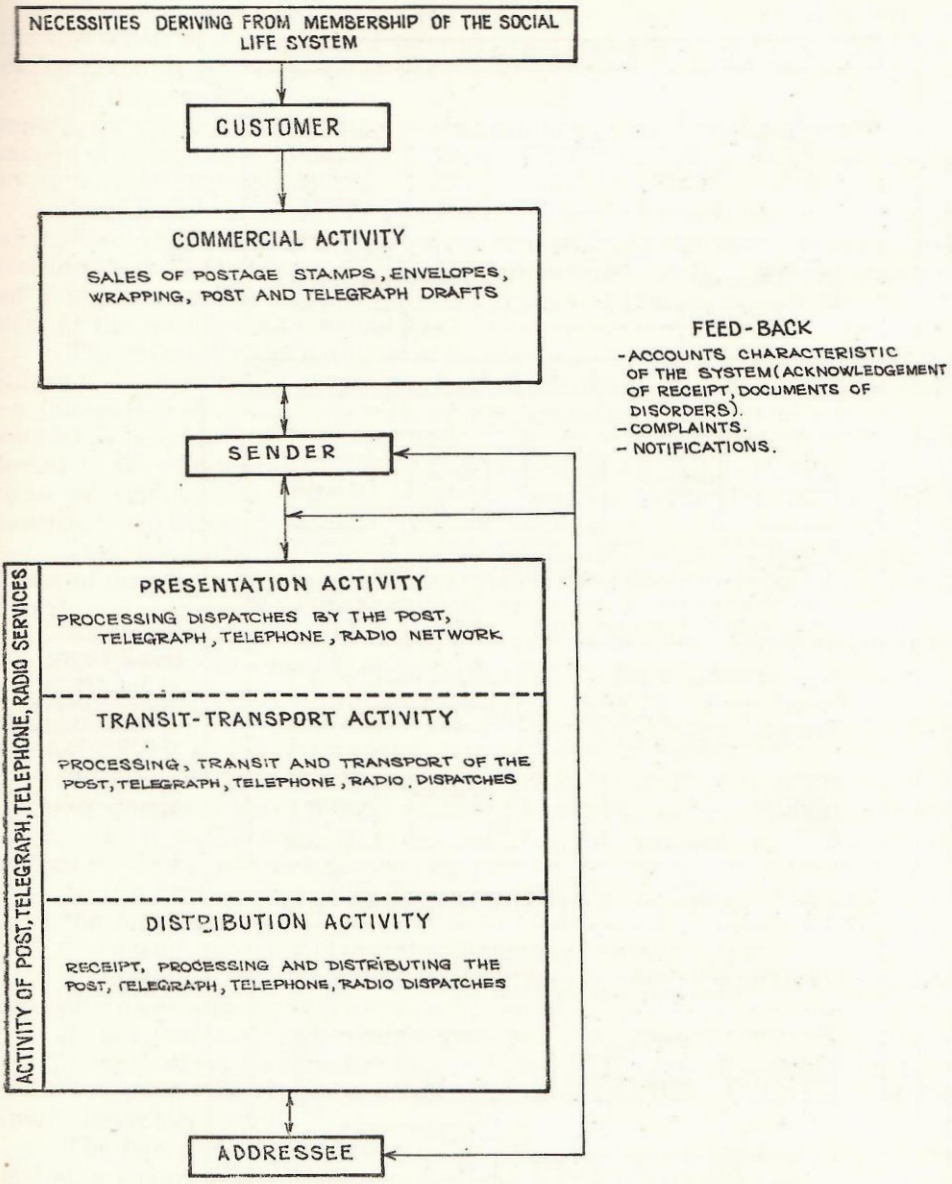


Plate 1: *Block scheme of the post activity system*

to the number of the communication sources (elements, subsystems) and to the number of the possible results. On the other hand, by considering entropy as an objective characteristic of the precision of the system's adjustment, the bigger the volume of apriori information, the greater will be the precision of adjustment, therefore its reliability.

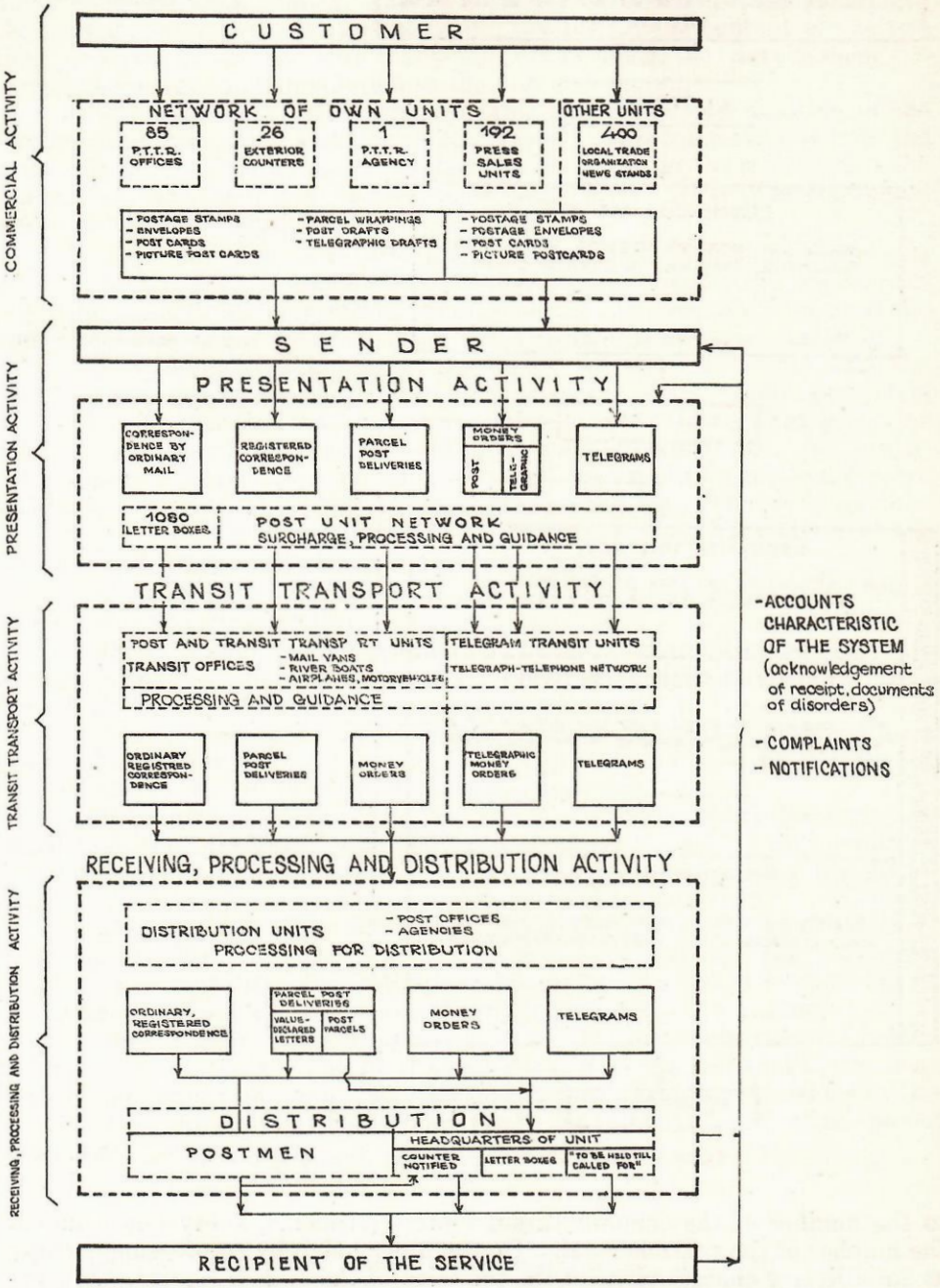


Plate 2: *Systemic representation of the post activity structure*

Thus, the necessity arises of elaborating a modelling information, namely the formation of a complex of informational models which should establish, define precisely and reflect the behaviour of the adjusted objective.

In the concrete case of the postal system, of the totality of the system's inputs, for the "service quality system", we have taken into account the parameters showing the lack of quality. It implicitely results that we define quality by a lack of the quality.

As it is only natural, the establishment of the quality indices implies an anatomical research, if not of the system, at least of the variables taken into consideration. The econometric and statistical-mathematical means represented a big volume of work, but we consider the certitude as regards the correctness of the results as compensational.

The enterprise's policy of quality produces feed-back effects; besides the information from the managing system to the managed system we also have an informational connection with an inverse sense which permits to modify control in keeping with the behaviour of the system. This mechanism is manifested to the effect that the structures, factors and correlations of the system must develop antientropically, respectively in a sense opposite to non-determination and disorganization.

Therefore, after the quality indices are established (plate 3), the problem arises of an adequate organization of quality control, so that for each hierarchical stage, it should fulfill its double role:

— a passive role which consists in establishing, registering and proposing sanctions for the deviations from the quality prescribed, and

— an active role, which consists in providing to the managing staff on each hierarchical stage, the instruments (the managing methods) through which the former can secure a permanent improvement in quality.

Whether we graphically represent the organization of quality control, denoting on the abscissa by n = the number of controlled indices and on the ordinate by S = the degree of their synthesis, a hierarchization of the quality system would be achieved, as seen on plate 4.

In this context, the problems put by the organization of quality control were the following:

1. control must be secured by the present existent staff;
2. control should cover the main activities in keeping with the established quality indices and scales;
3. the results of the control made at one of the present hierarchical levels can be synthetized so that the higher hierarchical level should have a more exact image of "the situation of the quality of processes or services", at the lower hierarchical level.

The last problem put great difficulties in finding a solution. This could be but a cybernetic solution.

What we have shown so far also represents the elements of the generality of the study. The objectives, the way of approach and the solutions are the same because the spheres of services don not matter. To prove this, we have applied the results of research in postal services, having established a cybernetic model for quantisizing their quality.

For this, we have taken into account that for the statistically investigated sets with a view to selecting the quality indices (respectively the main

Current number	Quality index	Characteristic activity	Pattern drawn
1	Sendigs admitted upon presentation with the address incomplete	Presentation activity	215 regist. letters
2	Erroneous sorting of correspondence	Processing activity	160 letters
3	Delivery not complying with directions	Distribution activity	150 regist. letters
4	Telegrams admitted upon presentation with an incomplete, confused or illegible text	Presentation activity	90
5	Telegrams transmitted by surpassing the control times	Transmission activity	30 telegrams
6	Telegrams received with transmitting errors for which the possible corrections were not demanded	Receiving activity	50 telegrams
7	Telegrams delivered by surpassing the control times	Distribution activity	50 telegrams
8	Disorders with money orders	Money order activity at all stages	10,000 money orders
9	Disorders with parcel post deliveries	Activity of parcel post deliveries at all stages	10,000 parcels
10	Compromised subscriptions	Activity of contracting press subscriptions with the Post, telegraph, telephone, radio office	100 copies
11	Unserved subscriptions	Activity of processing and ordering of subscriptions	100 copies
12	% returned publications	Activity of retail sale	100 copies

NOTE: For the pattern of 10,000 copies for the money order and parcel post deliveries of controlled services is used.

Scale (errors per pattern)							
expressed in number of disorders				expressed in entropies			
presentation office		distribution presentation office		presentation office		distribution presentation office	
min.	max.	min.	max.	H_0	H'_0	H_0	H'_0
22	33	26	38	0.4764	0.6186	0.5312	0.6730
—	—	1	3	—	—	0.5448	0.1344
—	—	12	18	—	—	0.4022	0.5294
7	9	7	9	0.3943	0.4690	0.3943	0.4690
—	1	1	2	—	0.2109	0.2109	0.3534
—	—	1	2	—	—	0.1415	0.2423
—	—	2	4	—	—	0.2423	0.4022
—	4	—	4	—	0.0051	—	0.0051
—	4	—	4	—	0.0051	—	0.0051
2	3	7	10	0.1415	0.1944	0.3660	0.4690
—	—	1	2	—	—	0.0808	0.1415
—	—	2	4	—	—	0.1415	0.2423

in case of offices with a reduced volume the comparison level 0.04 disorders for 100 pieces

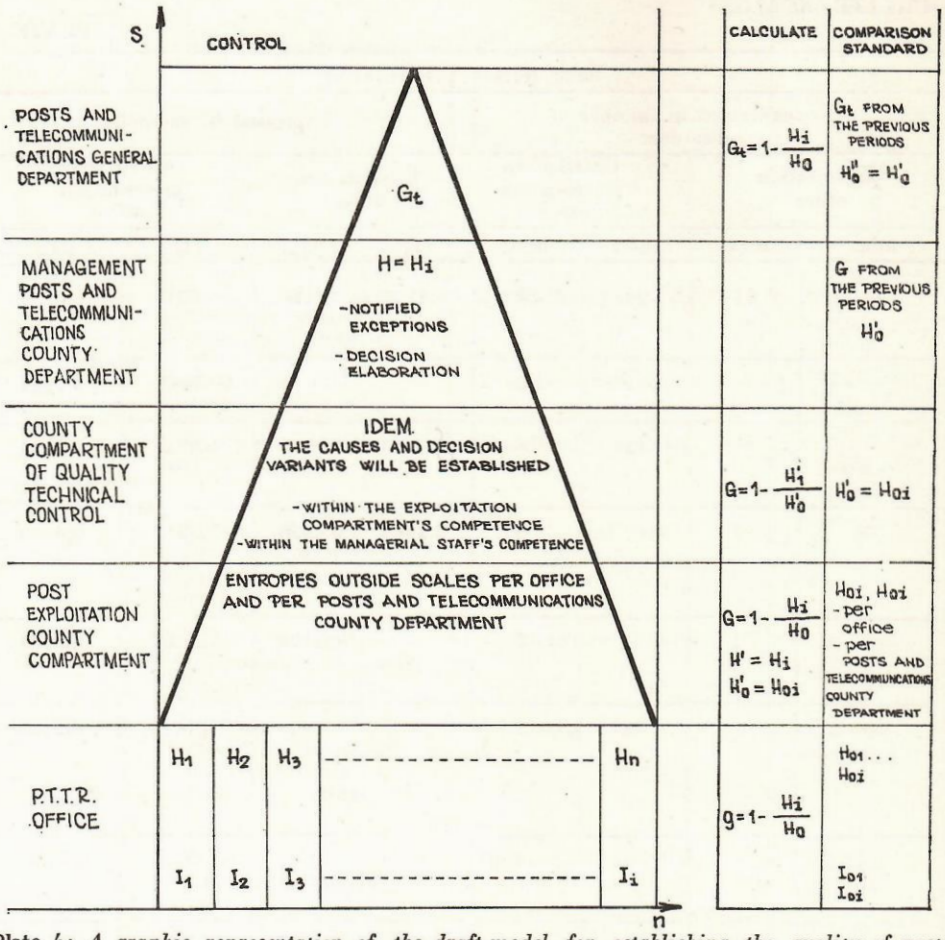


Plate 4: *A graphic representation of the draft-model for establishing the quality of posts services*

quality disorders), it was established that the distinct elements contained by each given population were two:

— "correct" dispatches, and

— dispatches containing the error or mistake pursued.

In the context of this study, the quality indices represent quality disorders, because the conception of the research was based on the selection of disorders and their designation as the content of the respective indices. The conception has in view the seeking of solutions for limiting these disorders their quantisization being represented by the scales.

By following a binary logic, it has been established that the activity of the postal services systems may be estimated as satisfactory or unsatisfactory, under the conditions of Shannon's relation for entropy.

$$H = -p \log_2 p - (1 - p) \log_2 (1 - p)$$

The analysis of the entropic states permits the establishment of the degree of organization of the services systems at the level of each organizational system.

In the situation of conditioning by maximum limits, the case of characterizing the state of quality by "lack of quality", for a postal, telegraph, telephone and radio office, a group of offices, a territorial post and telecomunication unit or the entire branch of activity, the degree of organization was calculated by weighting the degree of organization of each unit at the lower hierarchical level to its specific weight (α_i) within the system, by using relation:

$$G = \frac{\sum_{i=1}^{n} g_i \alpha_i}{n_i \sum_{i=1}^{n} \alpha_i}$$

where: n_i = number of offices;
g_i = the degree of organization of each unit in the lower hierarchical structure;
α_i = the weighting coefficients showing the importance of each lower hierarchical unit.

The application of the cybernetic model in establishing the quality of services with the aid of entropic states has permitted to establish the degree of organization at the level of each office (plates no. 5 and 6), production compartment, unit's managing staff, by following the organizational steps presented on plate no. 4.

Under these conditions, the following could be established in keeping with the objectives pursued by each hierarchical stage:

— entropy (the evolution of the quantity of variety of quality) and the degree of organization of a quality index;

— the entropy of a group of quality indices and their degree of organization, plates no. 5 and 6;

— the entropy of quality in a branch of activity of the unit, its degree of organization, plates no. 5 and 6;

— the entropy of quality in a unit and of its degree of organization, plates no. 5 and 6;

— the entropy of quality in a branch of activity and of its degree of organization, plates no 5 and 6;

— the entropy of quality in a branch of activity and of its degree of organization, plate no. 7.

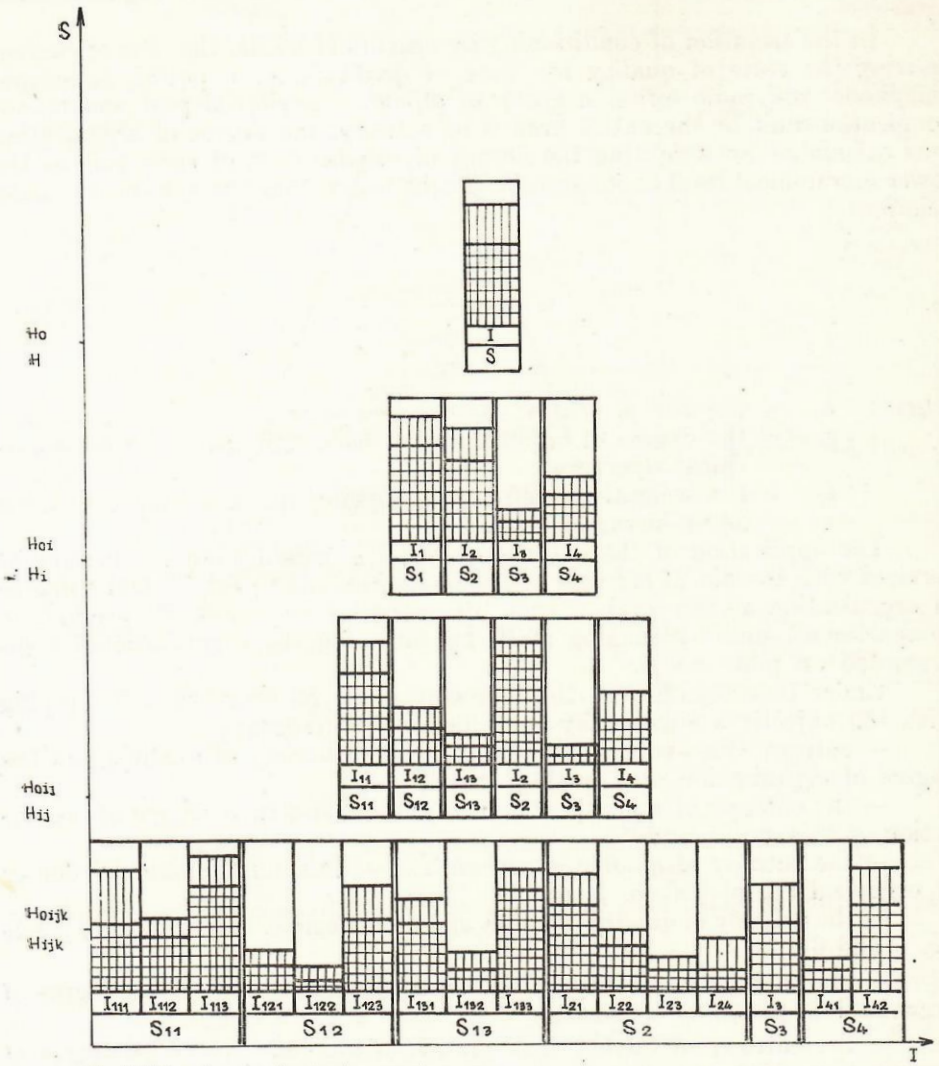
Consequently, on the whole hierarchical scale, quality may be measured by entropy, respectively in bits.

By using this method, the pyramid of quality control presented on plate no. 4 is achieved.

Practically, our design is equivalent to:

— the elaboration of specifications expressed in entropies for the use of quality technical control at various hierarchical levels;

— the management of quality by the method of exceptions.



S = P.T.T.R. and press distribution services system.

S_i = Services system on compartments of activity - post, telegraph, telephone, press distribution.

S_{ij} = Services system on stages of implementation.

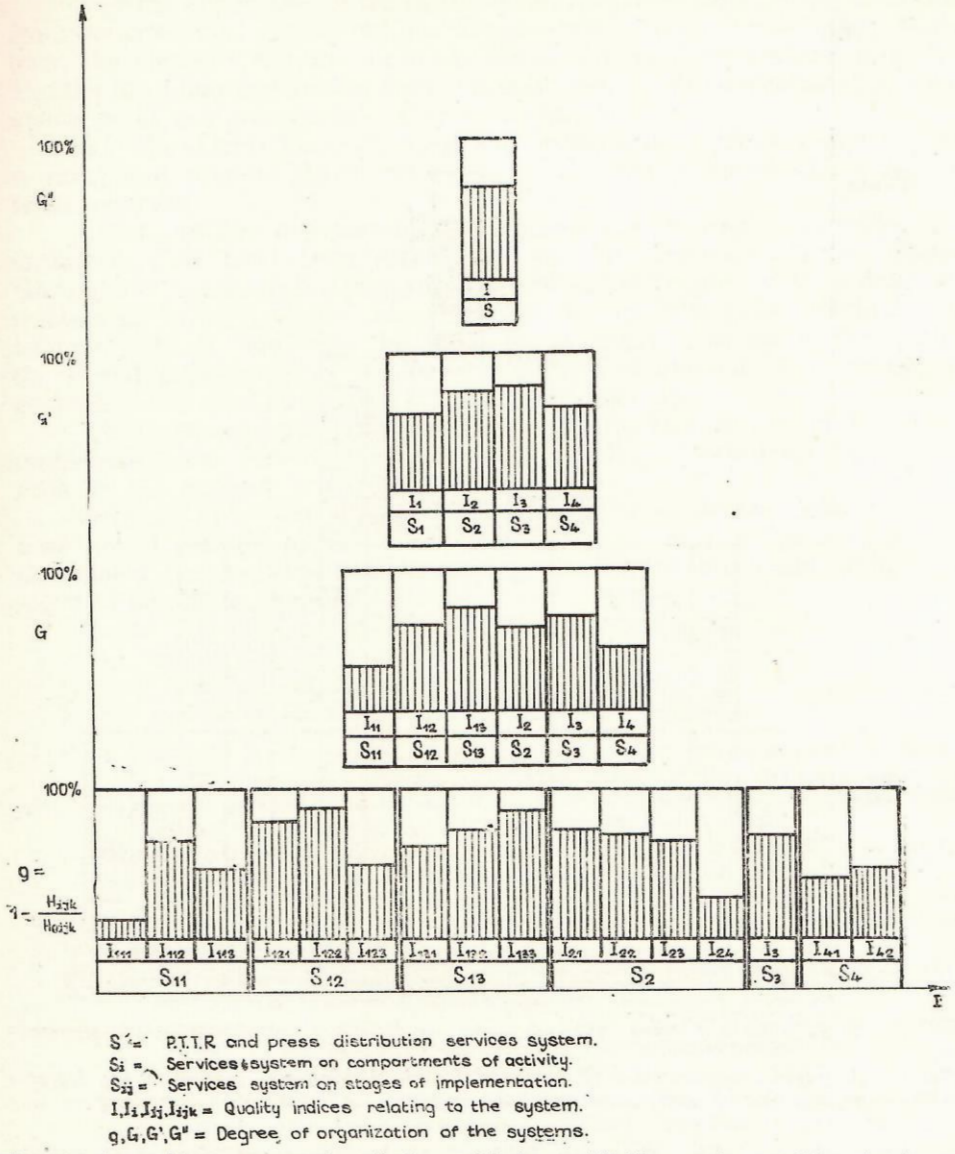
I = Synthetic quality index at the office level.

I_i = Quality indices at the level of activity compartments.

I_{ij} = Quality indices at the level of the category of services - correspondence, money orders, parcel post deliveries, telegrams, telephone conversations, press distribution

I_{ijk} = Quality indices at the level of each stage of service rendering correspondence - presented, guided, distributed; money orders - presented, guided, paid, etc.

Plate 5: *A graphic representation of the model for establishing and controlling the quality of P.T.T.R. services and the press distribution at the office level*



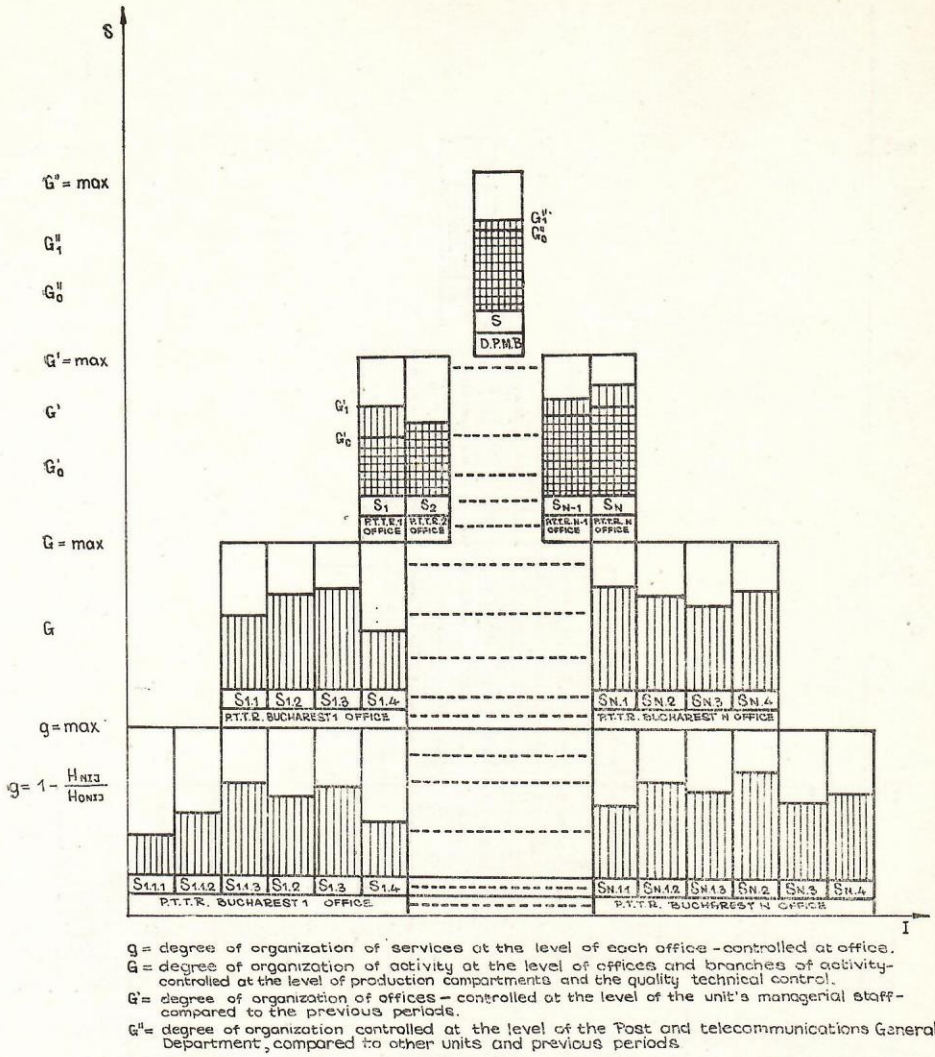
S = P.T.T.R and press distribution services system.
Si = Services system on compartments of activity.
Sij = Services system on stages of implementation.
I, Ii, Iij, Iijk = Quality indices relating to the system.
g, G, G', G'' = Degree of organization of the systems.

Plate 6: *A graphic representation of the model for establishing and controlling the degree of organization of services systems at the office level*

We consider the proposed method to be easily implemented within the present organization and with the existent staff.

Thus, practically applied within the Postal Department of Bucharest municipality, the model has proved:

1 — the implementation of the cybernetic method of quality quantisization can be done with the present staff and within the present regulations;



g = degree of organization of services at the level of each office - controlled at office.
G = degree of organization of activity at the level of offices and branches of activity - controlled at the level of production compartments and the quality technical control.
G' = degree of organization of offices – controlled at the level of the unit's managerial staff - compared to the previous periods.
G'' = degree of organization controlled at the level of the Post and telecommunications General Department, compared to other units and previous periods

Plate 7: *A graphic representation of the model for establishing and controlling the degree of organization of services system at the unit and the branch of activity level*

2 — the model has large possibilities of selfadjustment, the reaction limits of management being clearly defined. We refer mainly to the improvement of the scales calculated through the inverse functioning of the model;

3 — motivated estimations on the quality obtained for each service taken separately and for a group of services, execution unit (Post, Telegraph, Telephone, Radio office), department or branch may be put forward;

4 — the application of the calculi of the model creates possibilities of selfadjustment or adjustment of the system and enables a better knowing of the system;

5 — the application of the calculi of the model not only grasps deviations from the prescribed quality but also suggests the measures to be taken. Moreover, the degree of information of the decision-making hierarchical stage has also the flexibility required by the possible intentions of organizational improvments or of any other nature, they would like to make;

6 — the calculation of the degree of organization corresponding to each working unit permits the discovery and activation of its possible organizational reserves.

The necessities of research have required the drawing up of tables with entropies. This have been established on the computer of the "Ştefan Gheorghiu" Academy for patterns from 30 to 300 copies, with a defective fraction of up 50% of the volume of the pattern. The entropy tables may be used both in modifying the scales for their practical application within the Postal Department of Bucharest municipality and for those wishing to generalize the method in other branches of activity.

The practical application within the Postal Department of Bucharest municipality was done on the basis of the directions worked out to this purpose by the author.

May we point out that such models can be established also for other branches of activity in the sphere of services. So far, the Central Union of Consumers' Cooperatives and the Savings Bank have shown interest in knowing and applying the method.

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MODELE CYBERNETIQUE DE LA QUALITE DES SERVICES AYANT APPLICATION DANS LE SYSTEME DES POSTES

L'auteur présente les services postaux comme un „très grand" système cybernétique en acceptant l'idée qu'un tel système ne peut-être décrit que du point de vue statistique.

L'auteur expose les prémisses théoriques de la méthode pour la délimitation et la quantification de l'état d'entropie du système des services postaux, en considérant l'évolution dans le temps d'un champ de probabilité fini, formé par deux événements élémentaires et définissant ainsi, la caractéristique alternative de la qualité de ces services.

En utilisant un système de référence correspondant au spécifique des services postaux' l'auteur dispose le système général en sous-systèmes, dont chacun est traité en tant que système indépendant, tandis, que les indicateurs de la qualité et les barèmes correspondents sont établis à l'aide des méthodes statistiques et mathématiques.

La méthode permet de mesurer l'entropie d'un indicateur de qualité, d'un groupe d'indicateurs, ainsi que l'entropie de la qualité par groupes d'entreprises ayant un profil similaire, ou par secteurs d'entreprises selon les fins poursuivies par celui qui exécute le contrôle de la qualité.

Ayant pris pour point de départ un barème pré-établi pour la DIRECTION DES POSTES de Bucarest, l'auteur met à la disposition des spécialistes du domaine des postes de manière comparative, le matériel nécessaire à la quantification, au contrôle et à l'analyse de la qualité des services effectués et à l'estimation de leur efficacité et de leur fonctionnement.

КИБЕРНЕТИЧЕСКОЕ МОДЕЛИРОВАНИЕ КАЧЕСТВА СЛУЖЪЫ И ЕГО УПОТРЕБЛЕНИЕ В ПОЧТОВОЙ СИСТЕМЕ

Включая почтовые службы в сфере оболуживания, автор трактует их как «очень большую» кибернетическую систему согласуясь с идеей, что такую систему можно описать только на статистическом уровне.

Работа представляет теоретические предпосылки метода для разграничения и квантования этропического состояния системы почтовых служб, учитывая эволюцию конечного поля вероятности, состоящей из двух элементарных событий и определяя таким образом чередовательную характеристику этих служб.

Используя систему отчёта соответственно спечифике почтовых служб, автор разделяет их генеральную систему в подсистемы, причём каждая из них трактуется как независимая система установые статистико-математическими методами показатели качества и их соотвествующие пределы.

В зависимости от целей, преследоваемых иерархической степенью, совершающей качественный контроль, этот метод позволяет измерять энтропию качественного индикатора, а также энтропию качества по группам предприятий с подобным профилем, или по отдельным предприятиям и по их подразделениям.

Работа представляет собой для специалистов почтовой отрасли, инструмент практичексой деятельности, в кваитовании, прессследовании и анализе состояния качества служб и в оценке степени организования и эффективности оболуживания стравнительно с предназначенным эталлоном почтового управления города Бухареста.