podelu dohotka i investicione odluke prepušta dogovaranju i sporazumevanju relativno malih nezavisnih jedinica.

U procesu dogovaranja relativna pregovaračka snaga partnera, i na tržištu proizvoda i unutar preduzeća, očigledno ima strateški značaj. Verovatno zbog toga što se pretpostavlja da je centralnim planiranjem moguće eliminisati sukobe interesa, socijalističke ekonomije, i, sa retkim izuzecima, socijalistički ekonomisti, ignorišu dileme koje postavlja tržišna moć bilo unutar sektora ili preduzeća. Na mnogim jugoslovenskim tržištima potrošači se suočavaju sa visoko koncentrisanim oligopolima koji imaju moć da podižu cene do nivoa koji njihovim radnicima obezbeđuje abnormalno visoke dohotke. Jugoslovenska industrija čelika sastoji se od malog broja postrojenja (fabrika) koja nisu dostigla optimalnu veličinu. Kad ne bi bilo konkurencije uvoza, čeličane bi mogle da naplaćuju monopolističke cene.

Državna intervencija je pozvana da se nosi sa tržišnim nesavršenstvima utvrđivanjem plafona cena. Istovremeno, industrija čelika je bila nezadovoljna velikim obimom uvoza koji joj odvlači važne kupce, te je stoga ulagala napore da se putem dugoročnih ugovora podignu trgovinske barijere. Sve dosad ovakva taktika, međutim, nije se pokazala uspešnom.

Unutar vertikalno integrisanih preduzeća, ili radnih organizacija kako se ona sada nazivaju, normalan način poslovanja sastoji se u koordiniranom planiranju i striktnoj kontroli kvaliteta proizvoda u svim fazama procesa proizvodnje. Glavni proizvođači čelika u Jugoslaviji nisu napustili ove uobičajene postupke. U stvari, izgleda da su intenzivirani programi stimulacije na nivou pogona. Postoji veoma mali broj detaljnih informacija o samoupravnim sporazumima sklopljenim u vertikalno integrisanim organizacijama za proizvodnju čelika. Iz publikovanih svodnih prikaza i godišnjih izveštaja, međutim, moglo bi se zaključiti da radne organizacije u industriji čelika ulažu napore da ujednače dohodak OOUR-a (najmanjih jedinica koje uživaju autonomiju u pogledu odlučivanja o cenama, dohotku i investicijama). Ali prava OOUR-a koja im daju Ustav i Zakon o udruženom radu, izgleda da OOUR-i ne realizuju u slučajevima gde dolazi do izražaja pregovaračka moć. Umesto toga, davanjem prioriteta proizvodnom planu preduzeća kao celine, transakciona nezavisnost OOUR-a u velikoj meri apstraktnog je karaktera. U uslovima datih tehnoloških karakteristika vertikalno integrisanih proizvođača čelika, ovakav ishod ne treba da iznenadi, ako se želi očuvati interna efikasnost.

Organizacija industrije čelika u Jugoslaviji može se smatrati specijalnim slučajem u jednoj privredi koja je zasnovana na radničkom samoupravljanju. Njeno iskustvo pokazuje da se neke ključne odluke o promenama cena i investicijama ne mogu efikasno donositi na nivou preduzeća ili radne organizacije, a još manje na nivou OOUR-a. Pored toga, izgleda da je u ovoj industriji uloga OOUR-a ograničena barem kad je reč o odnosima unutar radne organizacije. Istraživanje drugih industrija, međutim, može otkriti veoma različite obrasce ponašanja u oba pomenuta slučaja.

INFORMATION ASPECTS OF MULTI-LEVEL PLANNING SYSTEMS IN SELF-MANAGEMENT ECONOMY

*Slobodan OSTOJIĆ**

I INTRODUCTION

New trends in planning theory (particularly within the framework of mathematical economics) clearly indicate the need for new ways of organizing the information and decision processes. According to Malinvaud and Bacharach,[1]) the planning theory developed around the notion of activity analysis would have to study the properties of various planning procedures implying different kinds of organization. Unfortunately, the information aspects of planning processes have up-to-now been most extensively dealt with by the mathematical theories of decentralized economic planning (relying heavily on the restricted framework of the general equilibrium (GE) school) which have very little practical significance.

Attempts to investigate the information aspects of planning processes in a more realistic setting have been made by Kornai[2]), the followers of the theory of optimally functioning socialist economies (Kantorovich et. al. as discussed by Ellman[3]) and by cyberneticians such as Maimians[4]) and Greniewski[5]), who have attempted to apply cybernetics and general systems theory to economics. The works of these latter authors served as a starting point for Kornai in setting his general model of the economic system, which hopefully provides a broader conceptual framework for investigating the information aspects of planning processes.

There is no systematic description of the information structure of the planning sphere of the economy in contemporary system literature. In the USSR, the followers of the theory of optimal planning have contributed significantly to the reorganization of information collection and processing in OPOs (Central Planning Offices) and the change of the structures of information flows between enterprises and planners (Ellman[3])). Kornai has also contributed to the topic by suggesting the approach to modification of the existing information structure of the planning systems, particularly having in view the multi-level planning

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procedures. His main proposition is that any economic system is characterized by a definite information structure which reflects the type of socio-economic system, and which is in itself highly complex, unlike the simple information structure which is used in GE literature, namely the literature on decentralized planning procedures where the main question is to find informationally-optimal arrangements of adjustment processes (Hurwich[6]). The partial and limited contributions to the investigation of information aspects of real planning processes imply the *need for a comprehensive conceptual framework* suited to be used for research on the topic. An attempt to formulate such a conceptual framework will be made in this paper. The main tool of analysis will be the *information paradigm* denoting the approach of research on planning processes where emphasis is laid on the information collection, processing and distribution and on the analysis of information properties of the process (i. e., information efficiency, information decentralization, etc.). The main proposition of the information paradigm is that any economic process which is not *informationally feasible* is not practically feasible *via facti*.

Particular attention will be paid to the self-management planning process, which cannot be described realistically and analyzed by the traditional hierarchical concept of relations *centre-periphery* (note that all afore-mentioned theoretical contributions are based exactly on this concept).

The conceptual framework which will be elaborated here is designed to provide the answers to the following two questions: (i) what are the information requirements of different planners at different levels in the planing systems; (ii) how can the needed information be used effectively. The second question refers to designing informationally-efficient planning procedures.

II CONCEPTUAL FRAMEWORK

To formulate a broader framework for the description and analysis of information aspects of planning processes, we shall start from the basic propositions: (i) formal planning requires formal collection, processing and distribution of planning information; (ii) the planning process can thus be described as an *information process* and the planning system can be viewed as a subsystem of the integral *information system* of the enterprise or an economy; (iii) efficiency of planning procedure largely depends on the information technology used and vice-versa — sophisticated information technology can not be used in ill-structured non-formalized planning processes.

To study the *information aspects* of planning processes, we introduce the following basic concepts: (i) information structure; (ii) information efficiency; (iii) information effects.

Definition I: *Planning information structure* describes the planning *information types*, the *flows of information* between (and within) levels of the planning system in different phases of the planning process, *characteristics of information flows* and *distribution* of information through the economic system.

Let us introduce the following notation:

— R denotes the information structure; symbol r_1 represents the specification of planners' information requirements, and symbol r_2 planning information flows.

— S denotes the sets of all information types which are used in a given planning process; U is a vector of information flows, whose components are described by three indices, where the first denotes the serial number of the information types s_i; the second, the serial number of the sender, and the third, the serial number of the recipient; V is a *memory vector* whose components are described by two indices, where the first represents a serial number of the information type s_j, and the second, a serial number of the economic agent possesing the information type s_j. The following relation then holds true:

$$R = [r_1, r_2]$$

$$R = F(S,U,V)$$

$$r_1 = F(S), \quad S = (S_i, s_j)$$

$$r_2 = F(U,V)$$

$$i = 1 \ldots . m; \; j = 1 \ldots . n, \; i \; n \; m.$$

Knowing the planning information types s_i which are exchanged during the planning process and planning information types s_j which are »memorized« by planning agents at different levels of the planning system, we can determine the nature and volume of plan calculations done at each planning level. To characterize a given information structure R of a planning process, we can use the following descriptive model where the components of the information structure are arrayed by the phases of the planning process and, in extension, by levels of the planning system. (Tabular representation of the model is self-explanatory). The notation used has the following meaning:

— s_{ij} denotes planning information types classified by nature of information ($i = 1 \ldots 4$) where s_{1j} represent planning data, s_{2j} planning parameters, s_{3j} planned values (magnitudes) and s_{4j} *plan indicators*. All these information types can be classified according to j into several classification schemes, eg., by phases of the planning process and information modules (module of commercial, financial, technical, economic information), or by external and internal information types, by time scale, by information-technical characteristics such as code, physical properties of signals, quantity of information per signal, etc.

— I_p denotes the sender and I_p the recipient of s_{ij} information type.

— s_i denotes information types which are "memorized" by each planning agent I_m and s_q represents the quantity of planning information that is beeing either "memorized" or exchanged.

The descriptive model of planning information structure allows the specification of information requirements (r_1) and information flows (r_2). In other words, for *each phase of the planning process we can determine who actually plans, on the basis of which information types, which information types are effectively needed and how they flow through the system, who "memorizes" the key planning information, what is the intensity of information exchange and the level of "fineness", etc.* Similarly, this model enables us to identify "bottlenecks" in the information flows and to determine the basis for modification of a given information structure.

The model also allows for a comparison of different planning systems of *planning data, parameters, value, (magnitudes)* and *indicators* that are actually used. Thus we would get an informational comparison of different economic (planning) systems.

The characterization of a given information structure (R) is the first step in the description and analysis of information aspects of alternative planning processes. The next is to analyze the effects of any change of a given R on the performance of a planning process. The informational performance of any planning process can be expressed by two other basic concepts introduced here, namely, by the concepts of *information effects* of the planning process on the behaviour of economic agents.

Information efficiency is a well-known concept developed in Western literature on optimal adjustment processes (Hurwicz)[6] and is associated with the concept of optimality of an adjustment process (or planning process). Since we shall discard here the concept of optimal planning as being too restriotive for dealing with real-life situations, we shall offer an intuitively plausible definition of information efficiency.

> *Definition 2:* Of two alternative planning processes (belonging to the same class), the one which achieves the same quality of final plan with lower volume of needed information, higher speed of information flows, lower costs of information collection, processing and distribution, and higher proportion of effective flows in total information flows is considered to be informationally more efficient.

Elements by which we can determine a class of planning processes may be: type of plan (annual or long-range), level of planning (corporate or national economic planning), dimensions of planning (degree of details frequency) etc. Plan quality can *in principle* be represented by a vector of indicators such as indicators of plan effectiveness (degree of attainment of objectives), total elapsed time, costs versus benefits, degree of integration of partial plans, etc. Component r_2 of the information structure is a *control variable:* with given information requirements (r_1) the problem becomes one of finding such a structure of information flows (i. e., planning procedure) which would ensure that planners receive the required planning information as *quickly, effectively* and *efficiently* as possible.

Plan Information Structure

Plan informati-on structure / Planning process	Information types (r_1)			Information flows (r_2)						
	price	non-pr.	money							
	„fineness"	indicators		$I s_i$	I_p	I_p	$I s_i$	I_{m_1}	s_{ij}	direction
Planning basis and assumptions										
Objectives										
Guidelines and policies										
Preparation of plans										
Consolidation and integration of plans										
Selection and approval										
Implementation										
Control -monitoring										
- analysis										
- reporting										

In order to increase the informational efficiency of a planning process, we can modify the information structure by varying the elements of *planning systems organization, procedures,* and *methodology.* Literature on decentralized planning procedures pays full attention to alternative ways of constructing informationally-efficient planning schemes (procedures) (G. M. Heal)[7] while multi-level planning literature explores the possibilities of decomposing the planning systems in order to facilitate more efficient collection, processing and distribution of planning information.

The third basic concept by which we can study the informational aspects of planning processes is *information effects* of alternative planning schemes. Information effects of planning processes can be viewed as (i) effects of information exhanges during the process of construction of the plan, (ii) effects of final plans on the subsequent behaviour of economic agents and (iii) intervention effect of national economic plans (F. Martin)[9]).

The first effect is stressed by Konnai[10]), who views planning as a cognitive and information exchange process. Some specific problems appear here, namely, the problems of distortion of information which is exchanged and the problem of stimulation to follow the rules of the planning procedure and later to implement the final plan. These problems are prominent both in centralized administrative planning and indicative planning.

The second effect appears specifically in the parametric planning systems where macro plans are used as formal vehicles of coordination and uncertainty reduction.

In the simple *cybernetic model of Greniewski*[5]), the planning process is represented as a communication network consisting of information sources and information flows from the "centre" to the "periphery" and vice-versa. From the economic units, CPO receives reports on actual situations and transmits to them the forecasts, directives, plan tasks, etc., depending on the character of the planning system. This cybernetic model suggests the political character of the iterative planning procedures: economic units observe the regularities with which the CPO reacts to the planning information they send and thus economic units "learn" how to shape that information in order to influence the decisions of the centre. The communication network of this cybernetic model implies the following communication problems: (i) problems regarding quality and quantity of information exchanged, and (ii) problems of information feedback. Distortion of planning information is caused either by technical reasons or, what is more important, by purposeful falsification of information due to the existing stimulation structures.

Improving the information effects of macro economic plans entails the following problems: (i) organization of information flows and adequate institutional arrangements, (ii) the language of macro economic plans and ways the key information is distributed throughout the economy, (iii) reduction of uncertainty concerning markets, technology and expected behaviour of economic agents via dispersion of plan information through formal communication channels.

Planning under conditions of uncertainty would imply the study of the following problems: (i) *nature of information that plans transmit to decision-makers*, (ii) *feedback mechanism*.

Traditional literature usually does not discuss these problems. Since no plan can be based on complete information on environment and thus be perfectly up-dated, the procedures by which plans could be constantly adjusted to changes in environment are difficult to construct. Hence the problem becomes one of organizing the information flows in the planning system (i.e., the activities of observation, communication, processing and decision-making). Concerning the organization of information flows, Mallinvaud[1]) suggests that a practical plan language be formulated (aggregates, indicators, etc.) which would ease communication between levels of the planning systems, and that the amount of information that economic agents should send to higher levels be as small as possible.

In summary, the information aspects of alternative planning processes can be analyzed from the standpoint of their *information structures, information efficiency* and *information effects*. In the remainder of the paper, some specific information problems of self-management planning will be discussed, particularly the problem of coordination of activities of thousands of decentralized economic agents in a situation where there is no central planning authority and the traditional concept of "centre-periphery" cannot be justifiably applied.

III INFORMATION ASPECTS OF SELF-MANAGEMENT PLANNING

Different planning systems entail different information problems. Thus, Soviet-type planning would typically exhibit problems regarding the collection and processing of a large quantity of data in central and local plan agencies, and distortions of information during their flows through vertical communication channels. In the indicative planning systems, the major information problem would be that of the magnitude of information effects of macro economic plan. In French planning, for example, the issue is how to set principles regulating the information exchange between enterprises and CPOs, namely which information types should flow "upwards" and which should flow "downwards" (Mallinvaud)[1]).

The information structure of traditional Soviet-type planning contains "downwards" flows of directives, stimulations, etc., whilst "upwards" information flows contain mainly quantitive information types such as production possibilities of enterprises. ((M. Augustinovics).[12]) Here, also, the well-known phenomenon of distortion of information in each iterative stage of the planning process is prominent. Manove[13]) shows that central planners could achieve the balanced planned supply and demand only in a few iterative stages (providing the information is not purposefully distorted) even if they did not have detailed information on production possibilities of firms.

The social basis of this cybernetic outlook is self-evident. Efficient planning procedures (i.e., information exchange) are possible only if the following conditions are fulfilled: (i) economic agents at different levels have a definite need and economic interest for exchange of planning information; (ii) economic agents have a legally sanctioned obligation to regularly exchange required planning information.

Information loads of different planning systems obviously depend on their organizational structure and planning methodology. Decentralized systems exhibit greater information needs and more elaborate coordination mechanisms than traditional hierarchical organizations (G. B. Davies[14]). Similarly, the introduction of computer-based planning systems would change the information structure in the sense that

quantitative information should flow "downwards" and qualitative information — "upwards", as is shown by M. Augustinovics.[12])

In order to apply the conceptual framework and general questions discussed so far to the Yugoslav self-management planning system, we should first briefly characterize this system.

The following properties are important: (i) the system is a typical multi-level/multi-goal system entailing about 9 different levels of planning; (ii) the function of higher levels (such as state bodies at federal and republican levels, Federal chambers of commerce and planning bureaus, etc.) are exclusively of an information-coordinative type: all actual plan decisions are made by economic units according to their interests (objective functions); (iii) plans are essentially based on *social agreements on the plan basis*, where plan objectives, means and actions are formally established, thus allowing for the direct influence of workers on the content of annual or medium-range plans; (iv) plans of higher levels should be a reconciled and consolidated expression of plans of economic units, meaning that instead of administrative or parametric planning we have a *stricto sensu* bargaining social process; (v) in order that the planning process be efficient, a mechanism for reconciling the different interests of economic agents at different levels must be found.

This multi-level planning system can function efficiently only if all the planners different levels use a *common planning methodology, common planning calender*, and start off from *common basic plan assumptions*. The procedure of decentralized planning will never be *efficient* nor *convergent* if numerous planning agents at different levels base their plans on different, mutually inconsistent basic planning assumptions. The information role of higher levels is precisely to formulate and communicate through the economic system such common, basic planning assumptions.

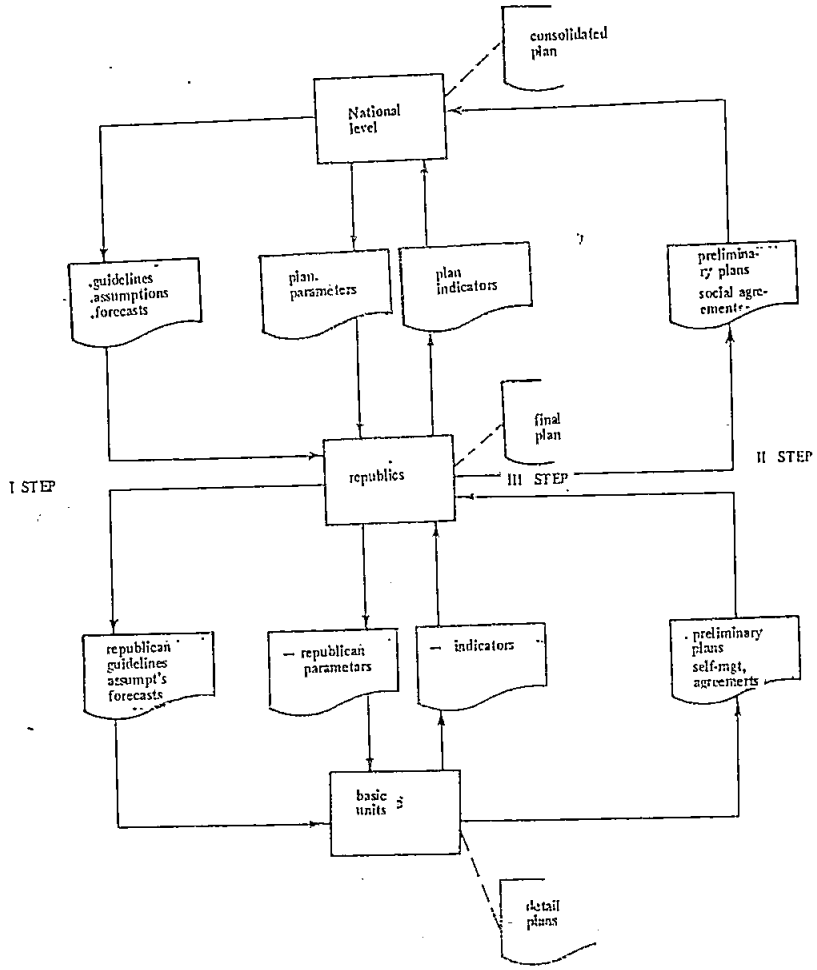
The key planning phase is *preplanning*, where the planning basis and assumptions are formulated and objectives are set. When the plans of different levels are well-grounded, it is easier later to reconcile and consolidate detailed plans. The procedure of detailed planning depends in its efficiency largely on the stability of key planning parameters (prices, interest rate, demand, etc.), and their stability can be significantly ensured by having a carefully performed preplanning phase.

The extent to which a system would function is presented on the following block diagram:

Key information and a coordinative role in this multi-level planning procedure is played by common planning *guidelines* and assumptions which are disaggregated down the planning "hierarchy" and adapted to specific situations or different planning levels. This information does not entail legally-sanctioned obligations but only serve as a formal vehicle of coordination in the preplanning phase.

"Social agreements on the basis of plans" are determined on the "bottom-up" principle, from the level of economic units to the level of the Federation. The input information of these agreements are first rough estimates of production, sales, income, investments, etc. The reconciled and finallized "social agreements" define the final planning

Self-management planning procedure



parameters to be used by each planning level in the phase of detailed planning (plan prices, interest rates, rates of accumulation, personal income, etc.). *The information structure* of this multi-level self-management planning system is the following: (i) in ten *preplanning* phase, information flows are dominantly vertical "downwards" and contain mixed qualitative information (guidelines, assumptions) and quantitative information (global forecasts, etc.). There are also significant ho-

rizontal information flows between economic units; (ii) in the phase of drawing "social agreements" on the plan objectives, means and actions, vertical "upwards" quantity information flows are dominant (rough estimates of production, investments, income, prices, interest rates, etc.) because only on this kind of information can objectives be realistically set, (iii) the phase of detailed planning is decentralized to the levels where detailed quantity and price information is naturally "memorized", and the information flows between levels consist mostly of obligatory, common plan indicators. This means that the cumbersome procedure of detailed data collection, communication and processing at higher levels is largely avoided; (iv) in the phase of plan implementation, vertical "upwards" information flows consist mostly of regular reports aggregated through the federal statistics and auditing service, whilst "downwards" flows contain largely current measures of economic policy.

The *information efficiency* of multi-level self-management planning procedures depends on the stability of planning parameters (set in preplanning phase) and the degree to which planning agents stick to approved "social agreements" defining plan objectives, means and actions.

In order for the planning procedure to converge quickly to a final, consistent (balances)and acceptable macro plan, it is essential that all levels should stick to their "social agreements" and send to "higher" levels planning indicators expressing their true possibilities and interests. The distortion of information is the main potential cause for inefficiency of self-management planning; disregarding the technical problems (which are not prominent since detailed plan information is not exchanged between levels but only rough esumates and concise indicators), we obviously encounter the crucial issue: the structure of stimulation and reconciliation (bargaining) of interests.

The second key issue is the standardization of planning indicators and aggregation errors. This can, in principle be remedied by improving the statistical system but this is a subject beyond the scope of this paper.

LITERATURE

[1]) E. Malinvaud, M. Bacharach, Activity analysis in the theory of growth and planning, Macmillan 1967, p. XIV.
[2]) J. Kornai, Antiequilibrium, North-Holland, Amsterdam, 1971.
[3]) M. Ellman, Planning problems in the USSR, Cambridge University Press, 1973, pp. 19—30.
[4]) E. Z. Maiminas, Processi planirovania v ekonomike: informaciony aspekt, Moscow, 1972.
[5]) H. Greniewski: Kybernetik und Planning, Wirtschaftswissenschaft (1963).
[6]) L. Hurwich: On the concept and possibility of informational decentrazation, AER, May, 1969.
[7]) G. M. Heal, The theory of economic planning, North Holland, 1973, ch. 2.
[8]) I. Kornai, Mathematical planning of structural decisions, North-Holland, 1975.
[9]) F. Martin, The information effect of economic planning, Canadian Journal of Economics, 4. 1964.
[10]) J. Kornai, A general descriptive model of planning processes, Economics of planning 1—2, 1964.

[11]) R. Radner, Economic planning under uncertainty, in: M. Bronstein ed. Economic planning, East and West Baillinger, 1976.
[12]) M. Augustinovics: Integration of mathematical and traditional methods of planning in: M. Bornstein, op. cit.
[13]) M. Manove, A model of soviet-type economic planning, AER, 3, 1971.
[14]) G. B. Davies, Management information systems: Conceptual foundations, structure and development, Mc. Graw-Hill 1974.

INFORMACIONI ASPEKT SISTEMA VIŠESTEPENOG PLANIRANJA U SAMOUPRAVNOJ PRIVREDI

Slobodan Ostojić

R e z i m e

Novi trendovi o teoriji planiranja jasno ukazuju na potrebu novih načina organizovanja procesa informisanja i odlučivanja. Nažalost, informacioni aspekti planskih procesa dosad su najekstenzivnije razmatrani u matematičkim teorijama decentralizovanog privrednog planiranja koje se snažno oslanjaju na ograničene okvire opšte teorije ravnoteže, te stoga imaju relativno mali praktičan značaj. Pokušaje da se informacioni aspekt planiranja istražuje u znatno realističnijem kontekstu učinili su Kornai, sledbenici teorije optimalnog funkcionisanja socijalističke privrede (Kantorovič i drugi) i kibernetičari kao što su Maiminas i Greniewski koji su pokušali da primene kibernetiku i opštu teoriju sistema na ekonomiku.

Parcijalni i ograničeni doprinosi istraživanjima informacionog aspekta stvarnih planskih procesa impliciraju potrebu za obuhvatnim konceptualnim okvirom koji bi bio pogodan za istraživanje ove teme. Ovaj članak predstavlja pokušaj da se formuliše jedan takav konceptualni okvir. Osnovna sredstva analize u ovom radu predstavlja tzv. informaciona paradigma, kojom se označava takav pristup istraživanju planskih procesa u kome se stavlja naglasak na skupljanje, obradu i distribuciju informacija i na analizu informacionih osobina procesa (npr. informacionu efikasnost, informacionu decentralizaciju, itd.). Osnovna propozicija informacione paradigme sastoji se u tvrdnji, da ni jedan ekonomski proces koji nije informaciono moguć nije praktično (u praksi) via facti, ostvarljiv.

U članku se posebna pažnja posvećuje samoupravnom planskom procesu, koji nije moguće realistično opisati i analizirati pomoću tradicionalnog hijerarhijskog koncepta odnosa centar-periferija. Inače svi napred pomenuti doprinosi zasnivaju se na ovom konceptu.

Konceptualni okvir koji se ovde razrađuje oblikovan je tako da pruži odgovore na sledeća pitanja: (1) koji su informacioni zahtevi različitih plānera na različitim nivoima u sistemu planiranja, i (2) kako se neophodne informacije mogu efikasno upotrebljavati. Drugo pitanje se u stvari odnosi na oblikovanje informaciono efikasnih planskih postupaka.