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INCENTIVES IN ORGANIZATIONS: THEORY AND PRACTICE

The paper contains the description of the modern state of art of incentive models and their applications: game-theoretical models of incentives in multi-agent, multilevel hierarchical intellectual active systems are considered and problems of model's identification are discussed. Five basic principles of incentives and motivation in organizations are formulated: principle of compensation, principle of decomposition, principle of aggregation, principle of cooperation and principle of generalization.

1. INTRODUCTION

In the framework of the management theory incentive problems are mostly studied for simplest organizations which consist of one principal and one agent [1, 3, 4]. Game-theoretical problem is formulated as following. Agent's goal function $f(y, s)$ reflects his preferences over the set $A \times M$ and depends on his own strategy $y \in A$ and on the strategy $s \in M$ of the principal. Define $P(s)$ - the game solution set as the set of the equilibriums [1, 6] under the given management $s \in M$. The management problem is: find $s^* = arg \max_{s \in M} \min_{y \in P(s)} F(s, y)$, $F(s, y)$ – principal's goal function, i.e. to maximize the guaranteed efficiency of management.

As the basic model, briefly described above, considers the simplest organization – intellectual active system (IAS) [1, 2], which consists of one principal and one agent, who make their decisions under complete information, the extensions of the basic model are generated by complicating the model sequentially. Any IAS is described by the following parameters [9]: members (elements) of the IAS (principals, agents, etc.); its structure (the set of relations between the elements); feasible sets of elements' strategies; goal functions of the elements; information possessed by the elements at the moments of their decisions making; the sequence of getting the information and making decisions. Thus main extensions of the basic model are: multi-agent IAS [5, 10, 13]; dynamic IAS [4, 10]; multilevel IAS [12]; IAS with distributed control (terms "control" and "management" are used as synonyms in this paper) [14]; IAS, which operate under uncertain environment or/and incomplete information [8, 9].

The main problem, which arises when applying results of theoretical investigation in practice [2, 7], is the problem of IAS identification [11]. Nowadays several levels of detailing exist. The most general one is to identify classes of possible values of IAS parameters. Sometimes such a general information (for example, corresponding to the assumptions of convexity of sets and functions in the model) is sufficient for restricting the class of optimal control variables. The next stage of detailing is the introduction of certain

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assumptions about classification of the model's parameters. And, at least, the last stage is to assign certain numeric values to the parameters of the model. This stage, being based correctly through natural or simulation experiments, allows to make reasonable conclusions about the optimal control.

The problems, mentioned above, are considered below in some details. Five basic principles of incentives and motivation in organizations are formulated: principle of compensation, principle of decomposition, principle of aggregation, principle of cooperation and principle of generalization (as the size of the paper is limited, the last two principles are described qualitatively – see the details in the referred literature).

2. INCENTIVE PROBLEM AND THE PRINCIPLE OF COMPENSATION

Consider deterministic multi-agent IAS, which consists of the principal and n agents. Agent's strategy is the choice of the action; principal's strategy is the choice of the incentive function (control parameter) – a mapping of agents' actions onto the set of their feasible rewards (remuneration). Denote $y_i \in A_i$ – an action of i-th agent, $i \in I = \{1, 2, \dots, n\}$ – the set of agents, $y = (y_1, y_2, \dots, y_n) \in A' = \prod_{i=1}^{n} A_i$ - a vector of agents action, $y_{-i} = (y_1, y_2, \dots, y_{i-1}, y_{i+1}, \dots, y_n) \in A_{-i} = \prod_{j \neq i} A_j$ - a situation of the game for i-th agent.

Preferences of the principal and the agents are reflected by their goal functions. Principal's goal function $F(\sigma, y)$ is the difference between his income $H(y)$ and total rewards of the agents: $u(y) = \sum_{i=1}^{n} \sigma_i(y)$, where $\sigma_i(y)$ – is the reward of i-th agent, $\sigma(y) = (\sigma_1(y), \sigma_2(y), \dots, \sigma_n(y))$. The goal function of i-th agent $f_i(\sigma_i, y)$ is the difference between the reward and his costs $c_i(y)$, i.e.:

$$f_i(\sigma_i, y) = \sigma_i(y) - c_i(y),\ i \in I, \qquad (1)$$

$$F(\sigma, y) = H(y) - \sum_{i=1}^{n} \sigma_i(y). \qquad (2)$$

Suppose that the principal and the agents at the moment of making their decisions posses the information about all the goal functions and all the sets of feasible strategies (this information is common-knowledge). The principal chooses his strategy first and reveals his choice to the agents, whereupon the agents choose the actions in order to maximize goal functions under the given incentive functions.

Introduce the following assumptions (an introduced assumption is considered to be valid hereafter):

A.1. $\forall\ i \in I\ A_i \subseteq \Re_{+}^{m_i}$ is a closed interval with the left end in zero.

A.2. $\forall\ i \in I$ 1) the cost function $c_i(\cdot)$ is continuous; 2) $\forall y_i \in A_i\ c_i(y)$ does not decrease in y_i, $i \in I$; 3) $\forall\ y \in A'\ c_i(y) \geq 0$; 4) $\forall\ y_{-i} \in A_{-i}\ c_i(0, y_{-i}) = 0$.

A.3. Incentive functions are piece-wise continuous and nonnegative.

A.4. Principal's income function is continuous and achieves its maximum on nonzero actions of the agents.

Denote *M* the set of feasible (satisfying A.3) incentive functions, $P(s)$ – the set of equilibrium (under the given incentive functions s) strategies of the agents (the type of equilibrium is not specified yet, except the assumption that the agents choose their actions independently and simultaneously and are not allowed to interchange additional information or utility), which is referred to as the set of implementable actions.

The efficiency of management (guaranteed efficiency of incentives) is the minimal value of principal's goal function on the set of actions, implemented by these incentives:

$$K(s) = \min_{y \in P(s)} F(s, y). \qquad (3)$$

The incentive problem is to point out the feasible incentive function s^*, which has maximal efficiency on the set *M*:

$$s^* = arg \max_{s \in M} K(s). \qquad (4)$$

In that specific case, when agents are independent (the reward and the costs of each agent depend only on his own action), the **principle of compensation** [9] states that the following compensative incentive function (if the principle must guarantee to the agent some reservation utility [4, 5, 9], then this utility is added to the compensated costs) is optimal (correctly - δ-optimal, where $d = \sum_{i=1}^{n} d_i$):

$$s_{iK}(y_i) = \begin{cases} c_i(y_i^*) + d_i, & y_i = y_i^* \\ 0, & y_i \neq y_i^* \end{cases}, \; i \; \hat{I} \; I, \qquad (5)$$

where $\{d_i\}$ are arbitrary small strictly positive constants. Optimal action y^*, implemented by the incentive function (5) as the dominant strategies equilibrium (DSE) [6], is defined as the solution of the following optimal incentive compatible planning problem:

$$y^* = arg \max_{y \in A'} \{H(y) - \sum_{i=1}^{n} c_i(y_i)\}.$$

3. INCENTIVES IN MULTIAGENT SYSTEM AND THE PRINCIPLE OF DECOMPOSITION

Introduce several definitions. The set of Nash equilibrium (NE) $E_N(\sigma)$ is:

$$E_N(\sigma) = \{y^N \in A \mid \forall\ i \in I\ \forall\ y_i \in A_i\ \sigma_i(y^N) - c_i(y^N) \geq \sigma_i(y_i,\ y_{-i}^N) - c_i(y_i,\ y_{-i}^N)\}, \qquad (6)$$

An action $y_{i_d} \in A_i$ is a dominant strategy of ***i***-th agent iff for any action $y_i \in A_i$, and any situation $y_{-i} \in A_{-i}$ $\sigma_i(y_{i_d}, y_{-i}) - c_i(y_{i_d}, y_{-i}) \geq \sigma_i(y_i, y_{-i}) - c_i(y_i, y_{-i})$. If under the given incentive function all the agents have dominant strategies, then the corresponding vector of actions is implemented by this incentive function as DSE. If the reward of each agent depends only on his own action, then the definitions of NE $E_N(\sigma)$ and DSE $y_d \in A$ take the form of:

$$E_N(\sigma) = \{y^N \in A \mid \forall\ i \in I\ \forall\ y_i \in A_i\ \sigma_i(y_i^N) - c_i(y^N) \geq \sigma_i(y_i) - c_i(y_i,\ y_{-i}^N)\}, \qquad (7)$$

The action $y_{i_d} \in A_i$ – is a dominant strategy of ***i***-th agent iff for any action $y_i \in A_i$, and any situation $y_{-i} \in A_{-i}$ $\sigma_i(y_{i_d}) - c_i(y_{i_d}, y_{-i}) \geq \sigma_i(y_i) - c_i(y_i, y_{-i})$. Fix some arbitrary vector of actions $y^* \in A'$ and consider the following incentive function:

$$\sigma_i(y^*, y) = \begin{cases} c_i(y_i^*, y_{-i}) + \delta_i, & y_i = y_i^* \\ 0, & y_i \neq y_i^* \end{cases}, \ \delta_i \geq 0,\ i \in I. \qquad (8)$$

The **principle of decomposition** [13] states that if the principal applies incentive function (8), then y^* is a DSE. Moreover, if $\delta_i > 0,\ i \in I$, then the DSE is unique, i.e. incentives (8) decompose the game of the agents.

If the reward of each agent depends only on his action, then, fixing the situation y_{-i}^* of the game as a parameter, the following incentive function is obtained from (8):

$$\sigma_i(y^*, y_i) = \begin{cases} c_i(y_i^*, y_{-i}^*) + \delta_i, & y_i = y_i^* \\ 0, & y_i \neq y_i^* \end{cases}, \ \delta_i \geq 0,\ i \in I. \qquad (9)$$

In this case the principle of compensation takes the following form [13]: if the principal applies incentive function (9), then $y^* \in E_N(\sigma)$. Moreover: a) if the following condition holds:

$$\forall\ y^1 \neq y^2 \in A'\ \ \exists\ i \in I:\ y_i^1 \neq y_i^2 \text{ и } c_i(y^1) + c_i(y^2) > c_i(y_i^1,\ y_{-i}^2) - \delta_i, \qquad (10)$$

then y^* is the unique NE; б) if the following condition holds:

$$\forall\, i \in I,\ \forall\, y^1 \neq y^2 \in A'\ \ c_i(y^1) + c_i(y^2) \geq c_i(y_i^1,\ y_{-i}^2) - d_i, \qquad (11)$$

then y^* is a DSE; в) if the condition (11) holds and $d_i > 0,\ i \in I$, then y^* is the unique DSE.

The optimal value of the vector y^*, is defined as the solution of the following optimal incentive compatible planning problem: $y^* = arg \max_{t \in A'} \{H(t) - u(t)\}$. The efficiency of the incentive function (9) is: $K^* = H(y^*) - \sum_{i=1}^{n} c_i(y^*) - d$. Theorems, proved in [13] state that the class (with a parameter y^*) of the incentive functions (8), (9) is d-optimal.

Results, presented in this section, were obtained under the assumption of noncooperative behavior of the agents. But, it is easy to verify, that the result about decomposition agents' game by (8), as well as the results of the next section, are also valid in the case, when the agents may form coalitions (under transferable and nontransferable utility).

4. INCENTIVES IN MULTILEVEL SYSTEMS AND THE PRINCIPLE OF AGGREGATION

In multilevel hierarchical systems [12] the agents may be well informed than the principal. Thus the problem of aggregation arises – what are the losses, caused by the aggregation of information about the activity of the agents, and what is the profit from this aggregation.

Let the output $z \in A_0 = Q(A)$ of the IAS is the function of agents actions: $z = Q(y)$. Principal's goal function $F(\sigma, z)$ is the difference between his income $H(z)$, which depends on the output, and the total remuneration of the agents (incentive costs) $u(z)$: $u(z) = \sum_{i=1}^{n} \sigma_i(z)$, where $\sigma_i(z)$ is the reward of i-th agent, $\sigma(z) = (\sigma_1(z), \sigma_2(z), \ldots, \sigma_n(z))$, i.e. $F(\sigma, z) = H(z) - \sum_{i=1}^{n} \sigma_i(z)$. Agent's goal function $f_i(\sigma_i, y)$ is the difference between the reward and the costs $c_i(y)$, i.e.:

$$f_i(\sigma_i, y) = \sigma_i(z) - c_i(y),\ i \in I.$$

If the actions of the agents are observed by the principal (or when the principal, observing the output, is able to recalculate uniquely the individual actions of the agents), the incentive function $\tilde{\sigma}$, based on the actions, may be used: $\tilde{\sigma}_i(y) = \sigma_i(Q(y)),\ i \in I$. The solution of the corresponding incentive problem is described above. So, consider the case when the principal observes the output and he is not able to recalculate uniquely the actions of the agents, i.e. the aggregation of information [12] takes place. Introduce the following assumption.

A.5. $Q: A' \to A_0 \subseteq \Re^m$ – is a single-valued continuous mapping ($1 \leq m < n$).

A Nash equilibrium $y^N \in A'$ is defined in the following way:

$$\forall\, i \in I \;\; \forall\, y_i \in A_i \quad s_i(Q(y^N)) - c_i(y^N) \geq s_i(Q(y_i, y_{-i}^N)) - c_i(y_i, y_{-i}^N).$$

Define the set of actions, which lead to certain output: $Y(z) = \{y \in A' \mid Q(y) = z\} \subseteq A'$, $z \in A_0$. If the principal compensates agents costs, his minimal incentive costs to implement the output $z \in A_0$ are: $J(z) = \min_{y \in Y(z)} \sum_{i=1}^{n} c_i(y)$. Define the set of agent actions, which lead to the given output and require minimal rewards to be implemented: $Y^*(z) = Arg \min_{y \in Y(z)} \sum_{i=1}^{n} c_i(y)$ and fix some vector $y^*(z) \in Y^*(z) \subseteq Y(z)$. Introduce the following assumption.

A.6. $\forall\, x \in A_0$, $\forall\, y' \in Y(x)$, $\forall\, i \in I$, $\forall\, y_i \in Proj_i\, Y(x)$ $c_j(y_i, y'_{-i})$ does not decrease in y_i, $j \in I$.

Consider the following two cases. The first one is when the principal observes the actions of the agents and he is able to base the incentives both on the actions and on the output. The second case is the case of unobservable actions, when the incentives may depend on the observed output only. Compare the efficiencies of management for this two cases.

In the first case the minimal incentive costs $J_1(y)$ to implement the vector $y \in A'$ of agents actions are: $J_1(y) = \sum_{i=1}^{n} c_i(y)$, and the efficiency of management is: $K_1 = \max_{y \in A'} \{H(Q(y)) - J_1(y)\}$. In the second case the minimal incentive costs $J_2(z)$ to implement the output $z \in A_0$ are (see above): $J_2(z) = \min_{y \in Y(z)} \sum_{i \in I} c_i(y)$, and the efficiency of management is: $K_2 = \max_{z \in A_0} \{H(z) - J_2(z)\}$.

The **principle of aggregation** [13] states that if the principal applies the incentive function

$$s_i^*(x, z) = \begin{cases} c_i(y^*(x)) + d_i, & z = x \\ 0, & z \neq x \end{cases}, \quad i \in I, \qquad (12)$$

where $x \in A_0$ is a planed output (parameter), this output is implemented as the unique NE with minimal incentive costs, i.e. (12) is the d-optimal incentive scheme, where the optimal value of the output $x^* \in A_0$ is defined as a solution of the following optimal incentive compatible planning problem: $x^* = arg \max_{z \in A_0} [H(z) - J(z)]$. Moreover, under the introduced assumptions the presence of information aggregation does not decrease the efficiency of management, i.e. $K_2 = K_1$. This statement, which was called the "theorem of ideal aggregation of information” [13] plays an essentially significant methodological role. It states, that, if the principal’s income depends on the aggregated output, then the efficiencies of management are the same when the incentives are based on the observable actions or when the incentives are based on the aggregated output (which is (by assumptions A.5 and A.6) less informative). In other words, the presence of information aggregation does not decrease the efficiency of management. This fact looks like a paradox, as in [9] was proved that the presence of uncertainty does not increase the efficiency of management. In the model, considered above, the ideal aggregation [12] takes place due to the principal's indifference between the agents actions, leading to the same output with minimal costs. Conditions A.5 and A.6 are sufficient for the principal's ability to impose the problem of equilibrium search on the agents. It allows to decrease the information, processed by the principal, without loss of efficiency.

5. INCENTIVES IN NETWORKS AND THE PRINCIPLE OF COOPERATION

In most project-oriented organizations the network or matrix management structure exists – when the activity of one agent may be controlled and provided by several principals, which belong to the same (distributed control [14]) or different (between-layers interaction [12]) levels of hierarchy, or, generally, the same element may in different situation (towards different elements) play the role of the principal of the role of the agent (network interaction [14]). Below in this section brief qualitative analyses of incentives in networks is presented.

The characteristic feature of matrix management structures is that the same agent is subordinated to several principals. In this case the principals, who are connected with the same agent, are involved in the "game", which is characterized by a rather complicated structure. In particular, two regimes of principal's interaction exist [14] – the regime of cooperation and the regime of competition. In the cooperation regime (when the interests of the principles do not differ crucially) principles act together (in order to induce the agent to undertake the required actions) with minimal joint resources involved. In the competition regime, which appears if the goals of the principals (reflected by the desired results of the controlled agent activity) differ essentially, resources are spent ineffectively.

Thus from the point of view of the whole IAS, the regime of competition is less efficient than the regime of cooperation. As the switching from the competition to the cooperation requires coordination of principal's interests, this coordination is a mean of management, implemented by the higher (than the considered principals) management authorities. When designing mechanisms of coordination, methods of incentive problem analysis, described above, may be used. The **principle of cooperation** states that in multilevel systems to obtain the efficient management of the whole system any management authority has to coordinate interests and goals of his subordinates, including the achievement of cooperation between the principles on the lower levels of hierarchy.

Besides the principle of cooperation, several important implications may be derived from game-theoretical analysis [12-14]. In multilevel structures principals are able to use management of several types, including institutional management and motivational management. Institutional management corresponds to the restraint or allowance of certain situations, strategies and so on. Motivational management consists in implementing management strategies, which depend on the actions and results of activity of the agents (i.e. incentives are motivational management). Hence the reward of the principals of the middle level may (and in most cases they must!) be based on the results of the activity of those agents, who are subordinated to this principal.

The characteristic feature of the network interaction between the members of the IAS is their potential ability to play both the role of the principal and the role of the agent. In the framework of the formal models, the criterion of labeling certain IAS member as a principal or as the agent is his priority in the choice of strategies – the principal is a meta-player, who chooses his strategy – management (which is the function of the agent's strategy) first, defining the "rules of the game" for the agent, who chooses his strategy under given management. Thus the hierarchical structure of the organization is generated by fixing the sequence of the strategies choices and information, possessed by the players at the moment of their decision-making. In particular, one of the reasons of management functions sharing is the necessity and the ability to increase the efficiency of IAS members interactions due to the decrease of uncertainty towards their behavior [14, 15].

6. INCENTIVES UNDER UNCERTAINTY AND THE PRINCIPLE OF GENERALIZATION

Most of socio-economic systems operate under uncertainty, i.e. principals and agents are not completely informed about essential internal and/or internal parameters. All deterministic models of IAS may be generalized to embrace the uncertain factors in the following manner. Information, possessed by the members of IAS, is described in terms of unknown parameters: feasible sets and/or probability distribution and/or fuzzy information [9]. Then some uncertainty removal procedure is applied (for example – maximal guaranteed value, mathematical expectation value, unfuzzy undominated value, etc.)), which allows to represent preferences of the IAS members in deterministic terms, i.e. being dependent from controlled variables only. Then the results of deterministic incentive problem exploration may be used to obtain the optimal solution (see the survey and results in [8, 9]).

Thus, one meaning of the generalization principle is that a model of IAS under uncertainty and results of its exploration must tend (with the "decrease" of uncertainty) to the corresponding ones, obtained for deterministic model.

Another (complementary) meaning of the generalization principle origins from the following identification problem: when formulating the game-theoretical control problem, we implied that the model of the IAS coincides with the real IAS. Let's consider the possible differences between the IAS and its model. Introduce the following assumption: the model of the IAS completely complies with the real IAS in all parameters, except the goal functions of the principal and the agent and the sets of their feasible strategies. Imagine the following situation. Let the control problem is solved for some model of the deterministic IAS under the assumption that all of the model parameters exactly coincide with the parameters of the real IAS. What may happen if the parameters of the model "slightly" differ from parameters of the real IAS?

Thus it may turn out to be that the problem has been solved for "another" IAS and one can not a'priori deny this possibility. So it is necessary to get the answers on the following questions [11]: is the optimal solution sensitive to the disturbances of the model description, i.e. will the "small" disturbances lead to the adequately "small" changes in the solution (this problem is referred to as the problem of solution's stability); will the optimal (in the framework of the model) solution remains optimal in the real IAS (this problem is referred to as the problem of model's adequacy).

The problem of the solutions stability, studied in the operation research, is connected with the "distortions", caused by the "measurement errors" and "computational errors", and is solved by the analysis of the optimal solution dependence from the parameters of the model. If this dependence is continuous, then small errors lead to the small deviations of the solutions. Then, solving the control problem on the basis of ill-defined data, one may be sure to find the approximate solution. If the dependence of the optimal solution on the parameters of the model is not continuous, or the solution is not defined in some vicinity of the exact solution, one have to apply the regularisation methods.

What may be treated as the adequacy of the model? The solution, which is optimal in the model, being applied to the real system, is expected to lead to the optimal behaviour of the IAS. But, as the model may differ from the real IAS, the application of this solution to the real IAS generally leads to some (observed) behaviour of this IAS. Obviously, the expected and the observed behaviour may differ greatly. Consequently, it is necessary to explore the adequacy of the model, i.e. to explore the stability of the real system behaviour (but not the stability of the model behaviour) towards the mistakes of modelling.

Thus, when identifying real IAS, one has to keep in mind the difference between the model and the object of modelling - absolute stability [11] of certain solution (which is ε-optimal in the model) in some domain means that it is ε-optimal in any other real IAS (and its model) from this domain. Moreover with the increase of *e* the domain of the absolute stability of some certain solution does not decrease. The assemblage of solutions (*e ³ 0* is the parameter) with the sets of models, in which they are guaranteed ε-optimal, was named the generalised solution of the control problem [9, 11]. The above definition of the generalised solution is broad enough as it exploits the set of all ε-optimal (in the model and in the real IAS) solutions. Hence for any solution, apart from its efficiency (the efficiency of control (efficiency of incentives)), whose "feasible" deviation from the maximal value depends on the parameter ε), there exists another characteristic - the set of IAS, in which it is ε-optimal, i.e. absolutely stable.

If the solution exists, which is ε-optimal in the real IAS, as well as in its model, then the model may be considered to be adequate (ε-adequate). Thus **the generalisation principle** [11] states that the main criterion of model's ε-adequacy is the efficiency of the real IAS control. The practical application of this principle is the recommendation for the operation researcher to suggest for the decision-maker not a unique solution of the management problem, but the generalised solution (moreover, the process of the model's analysis may be considered complete iff for any solution, satisfying the optimality principle, the sets of stability are indicated).

Qualitative reasoning presented above witness that there exists the dualism between the efficiency of the control and its stability. Trading the efficiency, one can increase the set of real IAS, in which the results of modelling may be applied. This effect reveals itself brightly in the analysis of the stability domains. The value of *e*, appearing in the definition of optimality, characterises the losses in the efficiency, which one is ready to admit. The dualism between the efficiency and the stability may be formally stated as following: the set of IAS, which are adequate to the fixed model, does not decrease with the increase of ε (and vice versa), moreover - the set of absolute stability of the fixed optimal (in the model) solution does not decrease with the increase of ε [9, 11]. This fact (relaxing the requirements to the efficiency of some solution, one can increase the domain of its absolute stability and, consequently, increase the domain of adequacy) demonstrates that to solve the problems of stability and adequacy it is sufficient to point out concrete dependency between the value of ε and the set of corresponding.

7. CONCLUSION

Exploration of game-theoretical model of incentive problems in IAS allows to point out the following general principles of incentives and motivation:

Principle of compensation states that agent’s costs (including reservation utility, etc.) must be compensated if the chosen action coincides with the recommendations of the principal. This principle plays key role in the analysis of all the incentive models.

When using incentives in multi-agent IAS, the principal should apply the following **principle of decomposition**: he offers to each agent – "If you choose the proper action, then I’ll compensate your costs regardless the choice of all other agents. If you choose any other action, then your reward will be zero”. Using such a strategy, the principal decomposes the game of the agents.

In multi-level IAS the **aggregation principle** is useful: minimal incentive costs of the principal to implement certain output are defined (without loss of efficiency) as the minimum of the total agents costs to undertake actions, which lead to this output. Joint application of the principle of decomposition and the principle of aggregation allows to find rational compromise in the dilemma: “reward for the process” versus ”reward for the output (terminal result)” [15].

Principle of cooperation, which is essential in network and/or distributed management structures, states that in multilevel systems to obtain the efficient management of the whole system any management authority has to coordinate interests and goals of his subordinates, including the achievement of cooperation between the principles on the lower levels of hierarchy.

In the IAS, which operate under uncertainty, the **generalization principle** allows to analyze the efficiency of generalized solutions (sets of solutions, obtained for different coordinated sets of models), defined as being rational taking into account all the available information and removing the uncertainty.

Application of these principles in practice (in enterprise personnel management systems, project management, etc. [1, 2, 7, 9, 12-14]) has demonstrated their constructibility and efficiency.

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