

# Decision Support at Cooperating Processes Management

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## Abstract<sup>1</sup>

This paper considers the problem of decision-making support by group of the managing directors occupied in cooperating processes. The integrated model including objective model of the decision-making support process for cooperating business processes, decision support ontology and knowledge representation model in the field of cooperating processes management was developed. The developed collective decision support system is based on using of the ontological knowledge base.

## 1. Introduction

The enterprise functioning efficiency in modern social and economic conditions considerably depends on the efficiency of developed management system at this enterprise. Therefore now a problem of business processes management, considering constantly increasing competition, fight for decrease in tariffs and expenses and as result, maintenance of profitability of work of all enterprise, becomes more and more actual. On the other hand, successful activity of modern enterprise is almost impossible without close interaction with other enterprises. These are the relations "manufacturing consumer", "seller buyer", "contractor-subcontractor" and other forms of business relationships. Integration with other enterprises on the basis of joint activity allows the enterprise to be steadier, competitive, to expand the sphere of the services, sales markets. The success of its activity depends on the effective organization and cooperating business processes management at the enterprise.

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The emergence of problem situations at management of enterprise activity is inevitable, to solve which it is necessary together. Thus, the whole group of managing directors, who often have the opposite purposes and preferences, takes part in management process. It is necessary to support in similar conditions of decision-making at cooperating business processes management, based on knowledge and management experience of the experts-managers group.

## 2. Collective decision-making support in cooperating processes

Cooperating business processes management of the enterprises is defined by a number of factors connected with features of the organization, functioning and condition of the enterprises which bring additional difficulties in management process. It is territorial remoteness of the enterprises from each other, insufficiently effective information interaction of managing directors at the various enterprises among themselves, and also large volumes of information which are necessary for considering at decision-making. Each enterprise has own information systems and databases, which are frequently not capable to be integrated into a uniform business process management system. The analysis of the interconnected and cooperating processes management shows that decision-making is carried out by groups of business processes managing directors at the various enterprises with the use of various information sources, efficiency criteria and decision-making methods. All this is at the bottom of low efficiency and inconsistency of decision-making.

Complexity of the decision choice and forecasting of its consequences is aggravated with that this process is practically always carried out in conditions of uncertainty and risk factors action, characterised for market economy. It considerably enhances the responsibility of those who

make decisions, demands much of their competence and personal qualities.

Making and implementing of collective decisions in problem situations (PS) – one of the most difficult aspects of management activity. Decisions in conditions of PS are accepted in a various operative situation, including crisis, and during extremely limited time that doesn't remove requirements for timeliness and validity of the decisions, complete and effective use of all available decision making person (DMP) possibilities. In similar conditions all-round, objective assessment of the situation and prospects of its development, distinct understanding of the directions and activity problems, knowledge of possibilities and resources necessary for a situation management is required. For collaboration of managing directors, developing the collective decisions, special methods and means of collective interaction support are developed: video and audio-teleconferences, e-mail, means of text files distribution and presentation in corporate Intranet networks, systems of electronic document circulation in big organizations.

These technologies and their realization instruments provide data and knowledge distribution among participants of cooperating processes, allowing employees to find information for business processes solution, to extend corporate knowledge among other employees, partners, suppliers, contractors and clients, with also to make an opinion exchange and collective decisions development. At the same time for management improvement in PS conditions it is necessary to automate the most labour-intensive processes of decision-making, as managing directors should generalize and estimate a big flow of arriving information at a short time, to react operatively to sharp changes of situation.

Difficult production systems management efficiency increase in conditions of uncertainty can be realized on the basis of knowledge and experts experience management, however, existing methods and means of managing directors decision-making support don't contain means of knowledge formalization in considered subject domain. Traditionally, the decision making persons are inclined to make the decision, being based on the intuition, past experience, and sometimes on corruption reasons. Such practice doesn't guarantee the coordinated decision and conducts to adoption of the subjective decision.

The task description formalization process for intellectual and analytical decision-making support rendering includes the preliminary data transformation, the choice of optimal (or rational) decision search model and a method and processing of the received results. Data transformation usually includes procedures of data choice for the task description and preliminary processing (transformation); the choice of optimal (or rational) decision search model and a method can be carried out on the basis of comparison the task description and the

fundamental mathematical schemes properties applied to decision-making; results processing consists in an assessment of the received decision versions, for example, the sensitivity analysis to changes of restrictions, etc. On each of these stages it is possible to choose various procedures options, taking into account existing difficult interdependence between them. It is offered to develop the ontology including the description of existing models and methods for decision justification rules formation and their optimization for intellectual and analytical support of the process. Applying the ontology, it is possible to carry out the search in space of available models and methods classes, in the view of solved tasks with preconditions which limit their application. Further decision-making support provides help to the decision making person in choice of models and methods for the performance, by ranging the analysis processes (heuristically) with that is important for the user, and also helps to define tools for realization of chosen method.

Application of decision support systems increases the speed of decision formation, increases their quality at the expense of alternatives choice mathematical justification and use of the formalized expert knowledge, and also allows to reduce considerably risk of erroneous adoption decisions owing to decrease in influence of a human factor on result. However efficiency, quality and risks of decision-making in decision support system in many respects depend on applied algorithmic providing.

Therefore, the corresponding models, methods and means of decision-making support, and also realization of operating actions are necessary for ensuring increase of management efficiency with cooperating processes in problem situations according to located resources. In this regard it is necessary to develop collective decision support system (CDSS), providing information and analytical support, ensuring managing directors information on the basis of the problem situation integrated description and forming the decision on the basis of expert knowledge and experience. In developed CDSS it is offered to unite a fundamental principle of the optimal decision search, typical for completely formalized tasks, with the use of the expert knowledge presented in the ontology of tasks, models and decision-making methods.

### **3. The integrated model of cooperating processes knowledge development**

The integrated model of cooperating processes is necessary for development of the decision support system. The model shows three various types models interaction: the objective model of subject domain and decision-making support process for cooperating business processes; the decision-making models and methods support ontologies; the knowledge representation models in the field of cooperating processes management. The integrated model development technique is given in [1].

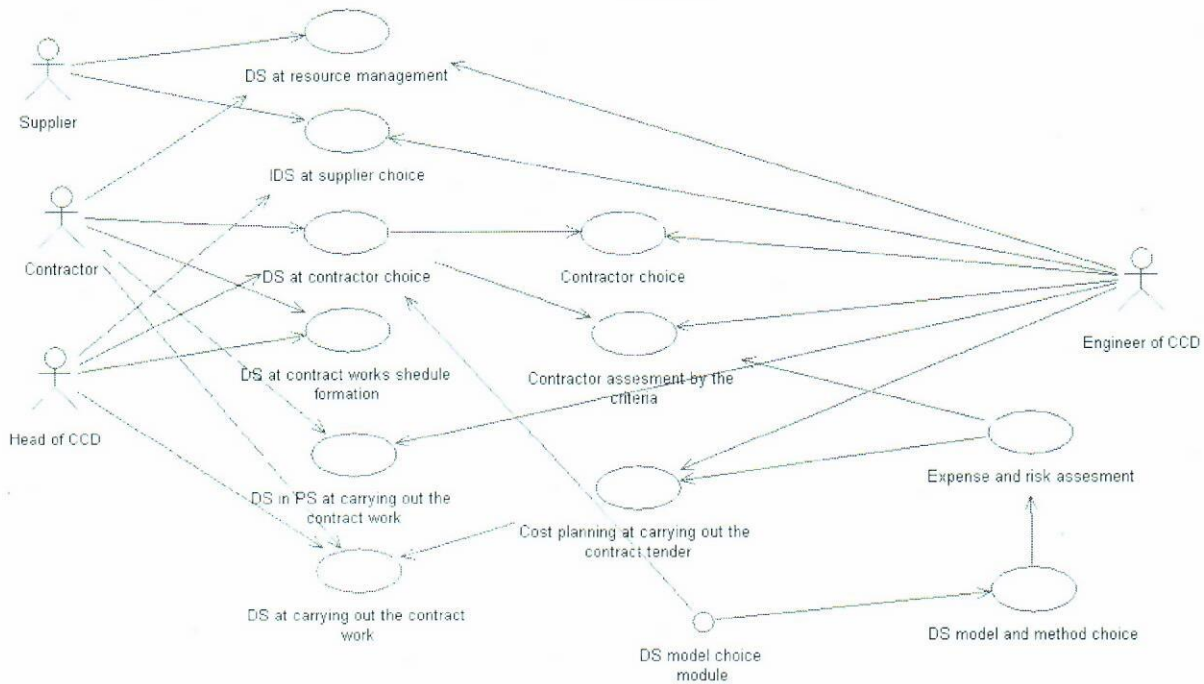
The objective model allows creating at the initial stages of design the certain formalized knowledge base about the processes proceeding within considered subject domain. According to the methodology of object-oriented analysis and design, the initial stage is the requirement analysis which means allocation of processes and requirements and their formulation in the form of use cases. The decision support requirement diagram at emergence of a problem situation (fig. 1) reflects management levels and hierarchy of the main decision support tasks. Requirement diagrams don't provide the cases hierarchy reflection in an explicit form – the hierarchy is defined by various types of communications between use cases and between use cases and actors.

Thus, as a result of objective modelling, developing of glossary and relation identification between terms it is subsequently possible to create the decision support ontology at cooperating production processes management.

It is should be noted that in subject domain analysis and modelling a requirement of concepts allocation from a large number of descriptive information, which will be subsequently classes or attributes of these classes, arises. [2, 3]. Therefore it is offered to form the glossary,

improving the understanding degree between the developers, experts and the decision-making persons. The objective model allows creating the certain not formalized model of processes knowledge representation proceeding within considered subject domain at the initial stages of design.

At the following stage of the integrated decision support model development the ontological analysis of decision-making support at cooperating business processes management is carried out. Ontology is the formal obvious description of concepts in considered subject domain (classes), properties of each concept, (slots; attributes; (sometimes called roles)), and the restrictions imposed on slots. Classes are in the centre of most ontologies. Classes describe the subject domain concepts. For example, the class of cases represents all available cases of problem situations arising in business processes. Concrete cases are the individuals of this class. The class can have subclasses which represent more concrete concepts, than superclass [4]. Decision support ontology development allows to achieve the general understanding of terms, carry out the information exchange, reuse knowledge, separate knowledge in subject domain from operative knowledge and to analyze knowledge in subject domain.



**Fig. 1. Requirement diagram of decision-making support at business processes management in construction**

The ontology, added by a set of problem situations rules and cases classes individuals, forms the ontological knowledge base. Knowledge and experience of experts about management in problem situations, for which rules in view of lack of a sufficient set of decision-making examples aren't formulated yet, are presented in the knowledge base in the form of cases of problem situations.

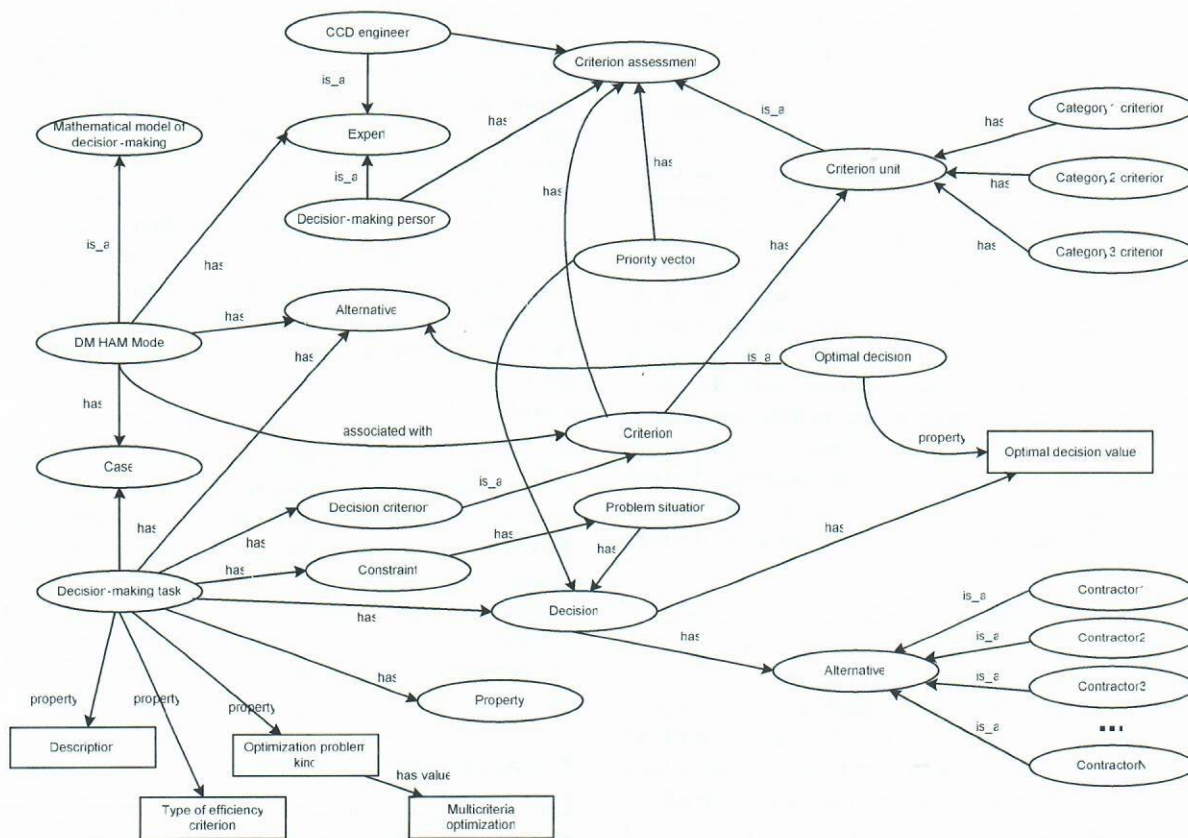
Conceptual basis of the ontological knowledge base are knowledge representation models in the form of subject domain concepts hierarchy, and also rules and the most significant decision-making cases in problem situations at cooperating production management in the form of descriptive logic axioms.

The knowledge representation model in the field of cooperating processes management includes decision-making rules, and also cases of problem situations in aggregate with the accepted decision generalizing experience of experts in considered subject domain. Components of decision support process (DSS) on the basis of knowledge management (group of sets) can be presented as:

$$DSS = (Rule, Case, M, E),$$

where Rule = { RuleCl, RuleCompl, RuleA } – a set of decision-making rules in problem situations, including subsets: subset of cases classification rules RuleCl; subset of cases descriptions replenishment rules RuleCompl; a subset RuleA of solving decision adaptation rules to the current situation; Case – a set of decision-making cases in problem situations; M – a set of decisions search methods, allowing to receive the reflection of set of alternatives into a set of decision efficiency vector estimates; E – set of decision cases efficiency criteria assessment.

The principle of displaying a set of cooperating business processes classes on a set of classes of decision-making rules in problem situations is taken as a basis of the ontological knowledge base structure. Strategy of the decision search with application of the ontological knowledge base depends on available information on a task and includes a way of alternatives choice, defined by structure of decision-making person preferences, and a method (model) of optimization. Problems of multicriteria optimization are solved with the application of a set of existing models and methods: the methods based on principles of individual preferences and voting procedures aggregation, a method of individual values additive convolution, a hierarchy collective analysis method, method ELECTRA, a method of consecutive concessions and others. The semantic network of mathematical modelling concepts and optimization problem solution methods which can be used in decision-making process is developed for a choice of the most adequate to a problem mathematical model in ontology [5].



**Fig. 2. Fragment of tasks, models and methods ontology**

For formation of a mathematical model semantic network a model structure and a subject-oriented knowledge is stored in ontology of tasks, models and methods (fig. 2). On the basis of this knowledge the mathematical model can be generated by means of corresponding variables, indexes, factors and restrictions identification from the menu of user interface [6]. As in ontology knowledge in

considered decision-making subject domain is presented also, the user (the analyst or the decision-making person) can form the task description according to the chosen mathematical model. Further, according to the associative relations between mathematical models and methods, the user can choose the decision-making algorithm corresponding to a concrete method, choose the algorithm

realization software and to calculate the priorities of decision alternatives. The developed integrated model contains the general cognitive elements, characteristic acceptances for collective decisions support: the concepts entering into the dictionary of cooperating processes management subject domain; the concepts necessary for knowledge processing, presented in rules and cases of problem situations; the concepts used in decisions optimization mathematical models and methods.

The developed integrated collective decision support process model at cooperating processes management is intended for formation of decision support system structure, and also system algorithmic and software.

#### **4. Collective decision formation algorithm with the use of CDSS**

Collective decision support system belongs to the class of intellectual information systems and combines expert knowledge and the knowledge formalized on the basis of integrated decision support model, and also the intellectual analysis of the data arrays saved up at the enterprise. The collective decisions information support with the use of CDSS is carried out as follows. At management of contract works performance cooperating processes on object building there are the problem situations which description is made on the basis of the most informative characteristics of operated processes. The description is used at query formation to CDSS which is entered to the search and decision adaptation module. Decision search is carried out with use of the ontological knowledge base containing rules and cases of decision-making in problem situations. Mathematical justification of formed decisions is made with the use of the collective decision optimization module, cooperating with the module of decision search and adaptation. Alternatives estimates calculation in collective decision optimization module is made with the use of the mathematical models chosen on the basis of decision support ontology.

As a result of CDSS work qualitative or quantitative recommendations about decision-making are provided. The offered CDSS should support the set level of adequacy and urgency of recommendations according to the current external conditions. For this purpose in CDSS the decision adaptation mode to the current situation with application of adaptation rules, made on the basis of knowledge and experience of experts in the field of problem situations management, is provided [7]. The problem situations cases, containing adapted decisions, are saved in the ontological knowledge base as new cases that provide the knowledge base learning. Experts carry out the efficiency control of made decisions and input of the efficiency estimates in to the cases description of CDSS ontological knowledge base. Thus, CDSS realizes the alternatives formation (search of possible decision versions) and the alternatives assessment (comparison of

options), and also recommendations submission to the users. The final decision making remains behind group of decision-making persons.

The module of the knowledge base, containing cases, is developed by results of the cases intellectual analysis according to a set of clusters, corresponding to standard mathematical schemes application to the solution of management problems in problem situation. The information structures, describing the knowledge about a concrete subarea, are associated with each cluster – the problem situation recognition rules and cases, containing concrete values of class individual properties, including the certain version of decisions in class "Decision".

At emergence of PS the user carries out the input of the PS description and if it is required, specifies and fills up the entered description. During the search the similarity measure, allowing to consider degree of concepts taxonomic proximity in ontologies and attributive similarity of problem situation signs description and cases, is used. By search of the nearest case the similarity measure, generalizing taxonomic similarity (based on the generalization relation between classes of essences) and similarity of problem situation and cases description signs (based on the relation of attributive proximity between properties of essence individuals), is used. The decision is taken from the nearest found case, and then if is required, adapts by special rules for the current problem situation. In case that the nearest case is not found, the problem situation description is remembered as not distinguished case, the decision-making person finds the decision independently or by means of experts, and CDSS suggests to keep the description of a decision-making problem as the new case in a learning mode of the knowledge base.

On the basis of certain sequence of actions at decision-making in problem situation, arising at cooperating production processes management, temporary costs of decision-making are analysed and the factor of decision-making efficiency is calculated when using CDSS. It is established that when using CDSS at cooperating processes management reduction of temporary expenses for decision-making at problem situation emergence is observed.

#### **5. Conclusion**

The developed collective decision support system provides qualitative or quantitative recommendations about decision-making; it supports the set level of adequacy and an urgency of recommendations according to the current external conditions. A basic purpose of decision support system is improvement of innovative technical support of products and services users (customers), wider technical competence necessary for satisfaction of client needs at expense of closer cooperation and knowledge exchange between groups of

cooperating business processes managing directors on the basis of a joint knowledge management.

process automation, increasing its efficiency and validity of formed recommendations for decision-making at emergence of a problem situation.

Decision-making support on the basis of system analysis and knowledge management, taking into account possibilities of modern information technologies, leads to essential results in cooperating processes management, providing higher efficiency of the occupied in business processes managing directors cooperation.

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