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## Cognitive approach in development of innovation management models for company

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### Abstract

The tendency of transforming from resource and export based economy to resource and innovation based economy (the tendency that is characteristic for both Russian and Azerbaijani economies) requires promotion of innovative activities in all levels of management – federal, regional, corporate and in the level of separate entities. (Makarov V.L., Bvarshavskiy A.Y. and etc., 2004) In connection with this, the question of development and introduction of effective systems of innovation management, and in the first turn, company innovation management systems, (CIM), which are the main constitutional elements of national economy systems, becomes essential. (Bazilevich A.I., 2009)

In modern complex economic conditions depth of processing CIM issues and substantiality of adopted management decisions is in the first turn and sufficiently determined by the quality of subsystem of scientific support. (Fatkhutdinov R.A., 1998)

The report considers opportunity of use of cognitive approach for developing CIM models. The methodology of development of cognitive models of CIM sufficiently differs from generally accepted schemes discussed in Materials of inter. conf. “Cognitive Analysis and Management of Development of Situations”. CASC’2007. Main differences are that, along with using basic provisions of cognitive approach, the methodology takes into account specific characters of subject field of CIM reflected in publications, and, secondly, considers reproductive character of the process of developing CIM models, providing for wide use of progressive technological practice of innovations.

*Keywords:* innovation management, strategic planning of companies, cognitive analysis of complicated systems

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### 1. Introduction

The tendency of transforming from resource and export based economy to resource and innovation based economy (the tendency that is characteristic for both Russian and Azerbaijani economies) requires promotion of innovative activities in all levels of management – federal, regional, corporate and in the level of separate entities. (Makarov V.L., Bvarshavskiy A.Y. and etc., 2004) In connection with this, the question of development and introduction of effective

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systems of innovation management, and in the first turn, company innovation management systems, (CIM), which are the main constitutional elements of national economy systems, becomes essential. (Bazilevich A.I., 2009)

In modern complex economic conditions depth of processing CIM issues and substantiality of adopted management decisions is in the first turn and sufficiently determined by the quality of subsystem of scientific support. (Fatkhutdinov R.A.,1998) Main factors determining quality of scientific support are scientific approaches and methods applied in the initial (conceptual) stage which is connected with selection of general direction of innovative development of companies.

Namely, in this stage, management of entities is everywhere facing with serious difficulties, arising from complex character of ill-structured (Pospelov D.A., 1986) innovation selection problem. Here opportunities for using traditional tools of support (expert methods, quantitative methods of analysis of innovative projects, IT-tools on the basis of Microsoft Office EPM and Microsoft SharePoint) are strictly limited. Along with this, under conditions of unstable transferring economy and uninterruptedly growing competition the question of scientific support of this stage is becoming more and more important and may be assigned to the most essential questions of theory and practice of CIM.

Methods of modeling ill-structured situations developed in recent years basing on cognitive approach open new perspectives for solution of the question. (Materials of inter. conf. “Cognitive Analysis and Management of Development of Situations”. CASC’2007)

The report considers opportunity of use of cognitive approach for developing CIM models. The methodology of development of cognitive models of CIM sufficiently differs from generally accepted schemes discussed in Materials of inter. conf. “Cognitive Analysis and Management of Development of Situations”. CASC’2007. Main differences are that, along with using basic provisions of cognitive approach, the methodology takes into account specific characters of subject field of CIM reflected in publications, and, secondly, considers reproductive character of the process of developing CIM models, providing for wide use of progressive technological practice of innovations.

## **2. Main provisions of cognitive approach**

Cognitive approach is a method of studying and managing situations basing on formation and study of cognitive models (cognitive charts). Cognitive chart is a structure (network) of cause and effect relations between the components of the system under survey and its surrounding environment, reflecting the conception of management person(s) about the structure and functioning of this system. The components of cognitive chart are: 1) basic factors – concepts characterizing the system and its surrounding environment according to the management person(s), as well as cause and effect relations between basic factors.

Although the term “cognitive approach” began to be used from 1960s actively, the elements of this approach were used lots of years ago. These elements were used during the scientific schools such as behaviorists, mentalists and etc. However, the difficulties in clarifying the behavioral events on the basis of “stimulus-reaction” made the behaviorists to apply to interim variables such as “cognitive map”. In the late 1950s and beginnings of 1960s the psychologists who were inspired with the successes in the field of computer, started researching the information processing by human intensively and offering the models for their explanation, which were the “prototypes” of cognitive approach. Cognitive approach was born in the research field of cognitive processes, which led to establishment of cognitive psychology. However, it went through the different fields of science and at the moment is on one of the main dominating approach almost in the all spheres of the science.

Cognitive revolution happened in 1950-1960s. The first cognitive research center was established in Harvard in 1960. This date is indicated as development of cognitive science (cognitology), which includes philosophy, cognitive psychology, neurophysiology, anthropology, linguistics and theory of artificial intellect.

The latest direction of this approach is connectionism, which describes cognitive system like the network of correlative elements. However, this direction is not wide-spread yet.

The main issue of the representatives of cognitive approach was proof of the important role of the knowledge in human behavior. One of these representatives is J. Piaje, who was researching the cognitive stages of children development.

P. Jane was calling her cognitive approach to the personality as “behaviorist” and was paying more attention to the role of self-control. According to his approach self-control considered to be the result of permanent contact of individual with surrounding him/her people.

According to U. Naysner the cognition exists in every act of the person: in feelings, mind, thinking, imagination and etc.

A specific feature of the cognitive modeling method differing it from traditional methods is the possibility of conducting multi-factor and multi-criteria analysis and management of development of ill-structured situations (combining vitally important stages of divergence, convergence and transformation of project cycle (J. Jones)) that is not possible through traditional mathematical calculations.

Methodology of cognitive modeling is addressed for analysis and decision-making in complicated situations. This methodology was suggested by Axelrod. (Axelrod R. *The Structure of Decision: Cognitive Maps of Political Elites.* – Princeton. University Press, 1976). It is based on modeling of experts’ subjective imaginations about situation.

Cognitive modeling is a periodic process and consists of several interrelated stages main of which are: cognitive structuring and development of cognitive model of surveyed situation; structural analysis of cognitive model of situation; scenario based modeling of development of situation.

*A. Cognitive structuring.* Identification of factors characterizing internal situation in the company and external processes (social and economic, political, technological and etc.) influencing its development. The cognitive structuration stage is formed as a cognitive chart (CC) describing a set of basic factors of the company and cause and effect relations between them. At present general feature for all works of cognitive approach is a cognitive chart as digraph (symbol or weighed) over a range of factors. (Pospelov D.A., 1986)

For each factor its value (or tendency of change) characterizing the subject, event or process associated with the given factor is determined. For cause and effect relations character and strength of interrelation between basic factors is determined. Values of appropriate variable are given on the basis of a linguistic scale, i.e. in words in a native language and each is denoted by a corresponding figure in the interval (0;1).

In this stage on the basis of set of basic factors also are determined: subset of target and subset of controlling factors, also, initial values and tendencies of change of basic factors. Factors relating to the company or to external environment, which the management of the company may influence on, are selected as controlling factors.

The basic factors are selected by **PEST-Analysis**, which divides these aspects into 4 main groups:

Policy

Economy

Society

Technology

*B. Structural analysis of cognitive chart.* This analysis is implemented to study structural features of CC which are important from the point of view of management practice. Such features include:

1) Non-conflicting purposes. The main point of the non-conflicting purposes vector is to ensure that desired change of some target factors does not result in undesirable change of others.

2) Non-conflicting purposes and controlling factors. Managing the situation is the change of controlling factors to the extent that would result in desired change of target factors, i.e. in the direction of planned dynamics. In connection with this, effectiveness of influence of controlling factors on targets of the company and conformity of controlling factors with the targets of the company is surveyed. Acceptable effectiveness of controlling factors is determined by the degree and character of their influence on the target factors. Conformity of controlling factors with targets vector means that no change of them should cause change in any of the targets in undesired direction.

At present a range of mathematical methods of structural analysis of CC has been developed. (Pospelov D.A., 1986) However, in practice, structural solutions achieved through these formal and mathematical methods require interpretations in the subject field, which are not always possible.

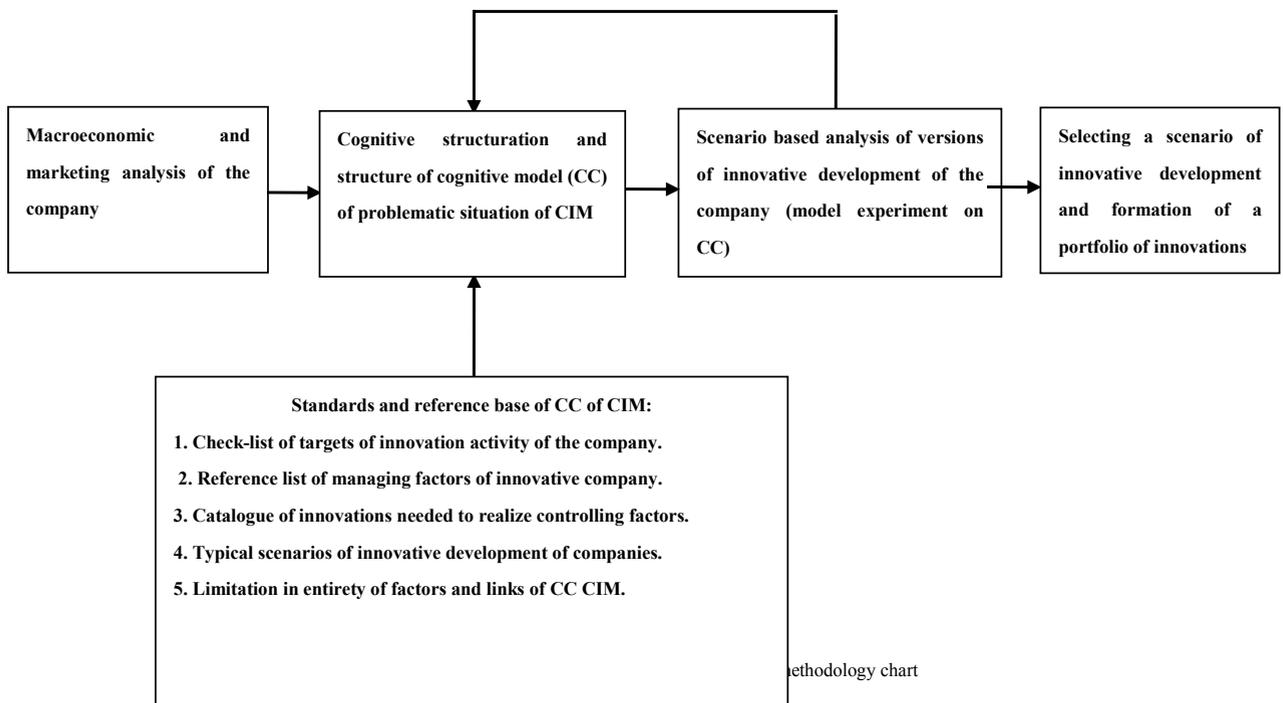
*B. Scenario modeling of development of situation.* This is conducted for comparative analysis of development of situation in different incoming managing impacts. Modeling may be conducted in self-development and controlled development situations. Development dynamics is modeled using F. Roberts’ apparatus for linear dynamic system. (Pospelov D.A., 1986) *Self-development* implies maintaining existing tendencies of factors and in essence, it is extrapolation of current situation taking into account mutual influences of basic factors. *Controlled development* of situation implies purpose targeted influence on one or several controlling factors. Impulsive change of current value of the factor which is transferred to other factors through the chains of impacts serves as management.

### 3. Features of developing cognitive models of CIM

Opportunities of cognitive approach may be used for modeling different tasks of CIM, and in the first turn, initial task of CIM connected with formation of conceptual project of innovative development and directed towards achievement of established targets of the company.

Our enough long experience (since 2002) in the field of cognitive technologies shows that in the process of developing cognitive models in production and economic spheres the use of not only and not such extent of explicit knowledge of management persons is extremely important (as it is introduced in the materials of Institute of Management Problems RAS, a leading scientific research institute in Russia in the field of cognitive technologies (Materials of inter. conf. “Cognitive Analysis and Management of Development of Situations”. CASC’2007.)), as use of all “status knowledge” of the subject field reflecting both international practice and specific nature of a particular company. (Organization for Economic Co-operation and Development (OECD). Science, Technology and Industry Outlook. 2008) This extra-personal knowledge of the subject field is achieved from the sources such as books, articles in magazines, standards applicable to particular sectors and technological registers of world’s leading companies in the given sector, analogical projects of leading companies and internet. Consequently, the question of reliability of cognitive models actively discussed in the works of the Institute of management Problems are solved not only and not so much by reliable application of knowledge of management personal, as it is achieved through maximum use of “high-profile knowledge” in the subject field.

The need for development of appropriate methodology for developing cognitive models of CIM was determined on the basis of these ideas. In presentations of cognitive approach general scheme of this methodology may be displayed as it is shown in Fig. 1.



**4. Example**

Application of cognitive approach in developing models of CIM has been described in the example of a machine-building company. (Bazilevich A.I., 2009)

Fig. 2 shows a piece of the cognitive chart reflecting production and economic status (a version) of the company.

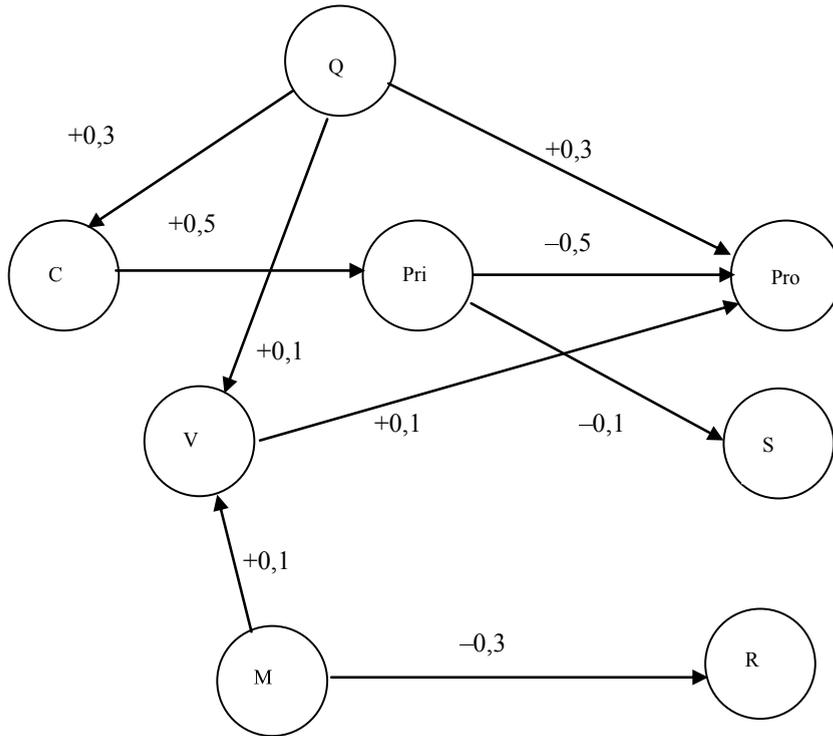


Fig.2. Cognitive chart of an innovative company (a version)

Basic factors of CC are the following:

- *Target factors:* Profit (Pro), Share in market (S), Risk (R) (risk of non-realization of innovation project).
- *Controlling factors:* Quality of product (Q), Price of product (Pri), Production cost of product (C), Sales value (V), Occupation of a place in a new market (M).

For assessment of “initial values”, “rates of change” and “degrees of mutual influences” of the CC factors the following linguistic scale has been applied:

- 0,1 – VERY LOW (VERY LITTLE, VERY WEAK)
- 0,3 – LOW (LITTLE, СЛАБОЕ)
- 0,5 - MEDIUM (MODERATE)
- 0,7 – HIGH (BIG, STRONG)
- 0,9 – VERY\_HIGH (VERY\_BIG, VERY\_STRONG)

Types of innovation scenarios which may be formed through changing values of controlling factors are listed in Table 1.

Table 1: Main scenarios of innovative development of companies

| Innovation scenarios                 | Types of reproduction of product   |
|--------------------------------------|--|
| S1: $Q_0 Pri_0 C_0 V_0 M_0$          | Reproduction on a simple scale (without innovations)   |
| S2: $Q_1 Pri_0 C_0 V_0 M_0$          | Reproduction of a higher quality product on a simple scale   |
| S3: $Q_0 Pri_1 C_0 V_0 M_0$          | Simple scale reproduction of a product with lower prices   |
| S4: $Q_0 Pri_0 C_1 V_0 M_0$          | Simple scale reproduction of a product on the basis of resource saving technology  |
| S5: $Q_1 Pri_0 C_0 V_1 M_1$          | Complex reproduction of a new product for old and new markets.   |
| S6: $Q_0 Pri_1 C_1 V_1 M_1$          | Complex reproduction of an old product produced on the basis of new technology   |
| S7: $Q_0 Pri_0 C_0 V_0 M_1$          | Simple scale reproduction of an old product for old and new markets  |
| .....                                |  |
| S <i>n</i> : $Q_1 Pri_1 C_1 V_1 M_1$ | Complex reproduction of new products produced on the basis of new technology for old and new markets (the most complex reproduction) |

#### Notes:

1. Index 0 means invariability of the value of the controlling factor (old version). Index 1 means variance of value of controlling factor. For example, improve of quality of the product – Q, decline of price – P, or production cost – C, increase in sales volume – V, extension of existing market or occupation of new market – M.

2. It is assumed that: a) if quality of the product is maintained, costs incurred by the customer remain unchanged, b) when quality of the product is improved, the rate of decrease of costs incurred by the customer is faster than the rate of increase of costs of the manufacturer, c) introduction of a new product on the basis of discoveries leads to improved quality and decrease of production cost of the product.

Projected cognitive model of CIM may be researched through “scenario based analysis” methods. (Materials of inter. conf. “Cognitive Analysis and Management of Development of Situations”. CASC’2007) These methods enable to generate various versions of innovation activities of the company, to assess their influences on the targets of the company and basing on this, to choose the most effective direction of innovative development. Thus, scenario based analysis of a model allows to determine general direction of innovative development of the company. Realization of selected direction requires appropriate innovations. (Bazilevich A.I., 2009) For this purpose, technological innovations Registers of leading western companies may be used or innovations reference Catalogue may be developed for the companies of respective profile. They may be used for realization of selected scenario, consequent detailed (quantitative) analysis of scenario and formation of innovations portfolio included in innovation project of the company

In the process of working on particular projects, we have developed such Catalogues (on the basis of foreign technologies) for:

- 1) specialized oil plant for production of lubricants, admixtures and special oils (purpose of project – improving the quality of products),
- 2) poultry farm of one of holding companies (purpose of project – extension of assortments of products, increasing share in the market),
- 3) steel works compound (purpose of project – using as raw material scrap metal and metal discard of many years of upgraded companies badly impacting ecology of respective region, supply of high-quality iron sheets to metallurgic plants in oil and gas sector).

## 5. Conclusion

Cognitive models described in the report may be referred to a new generation of CIM support tools. Models enable to conduct selection of the concept of innovative development of companies in hard conditions of transferring to resource and innovation based economy. Moreover, the experience we have gained show that creation of adequate and effective cognitive models of CIM (as well as in the case of other knowledge-based models) depends not only on formalities and schemes of conclusion used in these models, but also on comprehensiveness and quality of knowledge which is applied to them. Identification of such knowledge requires thorough study of deep semantics of the subject field and the specificity of functioning of each particular company.

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