ISSN 1992-6502 (Print)
Vol. 17, no. 6 (59), pp. 21-27, 2013.
Vestnik UGATU
ISSN 2225-2789 (Online)
http://journal.ugatu.ac.ru

UDC 004.7

ONTOLOGICAL APPROACH APPLICATION IN INFORMATION MANAGEMENT OF SOCIAL AND ECONOMIC SYSTEMS

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Submitted 2013, May 9

Abstract. In the paper an ontology model, describing some aspects of common information space, is presented. Management consulting and information management are described first, and place of information management domain in FEACO classification are shown. Then problems of management consulting organizations in addressing domain are analyzed. Then conception, based on common information space idea, aimed to solve some revealed problems, is proposed. It's specified for case of IT-infrastructure development management. Then method of estimation of quality of IT-consulting services is described.

Keywords: ontology model; description logics; information management; IT consulting.

1. INTRODUCTION

Federal Target Program "Electronic Russia" on the third stage involves the implementation of the mass distribution of information technology (IT) in the real economy. This is especially true for small and medium-sized businesses, including service industries, whose main activity is the production of information resources (ideas of staff / people and guidance for their implementation, accumulated in a form that allows their reproduction), or substantially dependent on them. Their development must be the basis for the establishment of the innovation economy in Russia. Basically best customer organization trying to solve these problems on its own or else seek the help of experts in the field of IT, but it is possible at an appropriate level of quality only in the solution of simple operational tasks, and to conduct a serious information management (collection of all necessary management decisions at all lifecycle of enterprise / organization, including all activities and operations associated with both information in all its forms and states, and now as a whole) without the assistance of professional consultants is not enough. Attempts to construct an information management on its own leads to an increase in costs to support and develop information systems that increase transaction costs of information. Help in doing so, they may have organizations that provide services to management consulting in the field of information management and interact with experts and providers of hardware and software. However, these services are often not in demand due to the relatively high cost, or not enough acceptable level of quality. One reason is the lack of qualified personnel for consulting organizations, due to the fact that the Russian system of higher education trains specialists in the field of consulting.

Consultancy – business with a high degree of risk. According to the rating agency "Expert" more than 20 % of consulting organizations go bankrupt in the first year after establishment, about 30 % in the second and less than half of them are more than four years. This is despite the imbalance of customer relationship organizations (to clarify that) the small and medium business in Republic of Bashkortostan (more than 125 thousand) and consulting organizations (about 40). The reasons are, in addition to the marked shortage of trained personnel, difficulty in finding best customer organizations, and the client organizations – the complexity of finding organizations that provide essential services of acceptable quality and cost, high staff turnover and reliance on advisers' skills. Another reason – difficult to exchange knowledge and experience (information resources) among the consultants, there is practically no exchange of experience among consulting organizations and between business organizations and consulting organizations, which requires the use of information systems, decision support and knowledge management.

2. MANAGEMENT CONSULTING AND INFORMATIONAL MANAGEMENT

Consider the specifics of management consulting services that will help in shaping the concept, because she should take it into account. The most important issues are the specifics [4]:

1. The dependence on the reputation of the consulting organization, and as a consequence, the degree of customer satisfaction.
2. Work closely with HR best customer organization.
3. Depending on the qualifications of consultants and frequent loss of experience due to the high turnover rate (about 20 %).
4. The high dynamics of changes in the external environment and the need for capitalization of knowledge.
5. A significant dependence of the main activities of customer relationship organization of information resources.
6. The complexity of assessing the quality of services

Accordingly, it is necessary that the proposed concept takes into account all these points.

But before this, briefly consider the place of information management in the classification Federation European Association of Consulting Organizations (FEACO). This is necessary in order to understand what types of services can be provided consultancy profile organizations that have been investigated in this article, because Contact Information management and management consulting is not obvious, and analysis of its almost not found in the literature.

As is well known [6], the tasks of information management are:

1. Formation of the technological environment information system.
2. Development of information system and ensuring its maintenance.
3. Planning in an environment information system.
4. The formation of the organizational structure in the field of information.
5. The use and exploitation of information systems.
6. The formation of innovation policy and implementation of innovative programs.
7. Personnel Management in the field of information.
8. Managing investments in the field of information.
9. The formation and maintenance of complex information resources.

In this regard, the most obvious affiliation information management to all types of counseling in the field of IT (IT-consulting, paragraph 7 and all the sub-classification) and Information Consulting (p. 8.05). In the intellectual economy begins to dominate the fifth technological way [8] with the dominance of information technology as a means of innovation, so it is appropriate to indicate it belongs to the management of innovation (p. 1.03), which echoes the above problem under the number 6. Also obvious connection with paragraph 4 (Human Resource Management), which echoes the challenge number seven, in particular, with increased training of employees (p. 4.18), as well as the organizational structure and development (p. 1.09). In the process of personnel management and service delivery information system needs training (p. 8.01).

3. CONCEPTION OF COMMON INFORMATION SPACE

Keeping in mind the results of analysis in previous section, Informational Management as a process has been investigated (see Fig. 1) and it's been allowed identifying the following types of services of management consulting in the field of informational management (except listed before):

1. Create IT-strategy.
2. Manage development of IT-infrastructure (ITI).
3. Automate business-processes.
4. Learn staff of client organization.

We now describe the concept as a system of views on the process of management consulting in the field of information management. In order to establish closer interaction between consultants and clients, save, convert and re-use the expertise of consultants and other electronic information resources that arise in the process of consultation, proposed to create a common information space as a platform for interaction between consulting actors: consultants, staff of customer organizations and experts in the field of IT. It includes the following (see Fig. 2):

1. Storage in the form of several ontological knowledge bases.
2. Information resources created and used in the process of management consulting.
3. Interface access to information resources as a subsystem of the overall information system (public Internet portal and deployed on their base of corporate intranet portals).
4. Community of experts in the field of IT, which should be governed by a subsystem of a group of expert evaluation.
5. Information subsystem of interaction between the consultants.

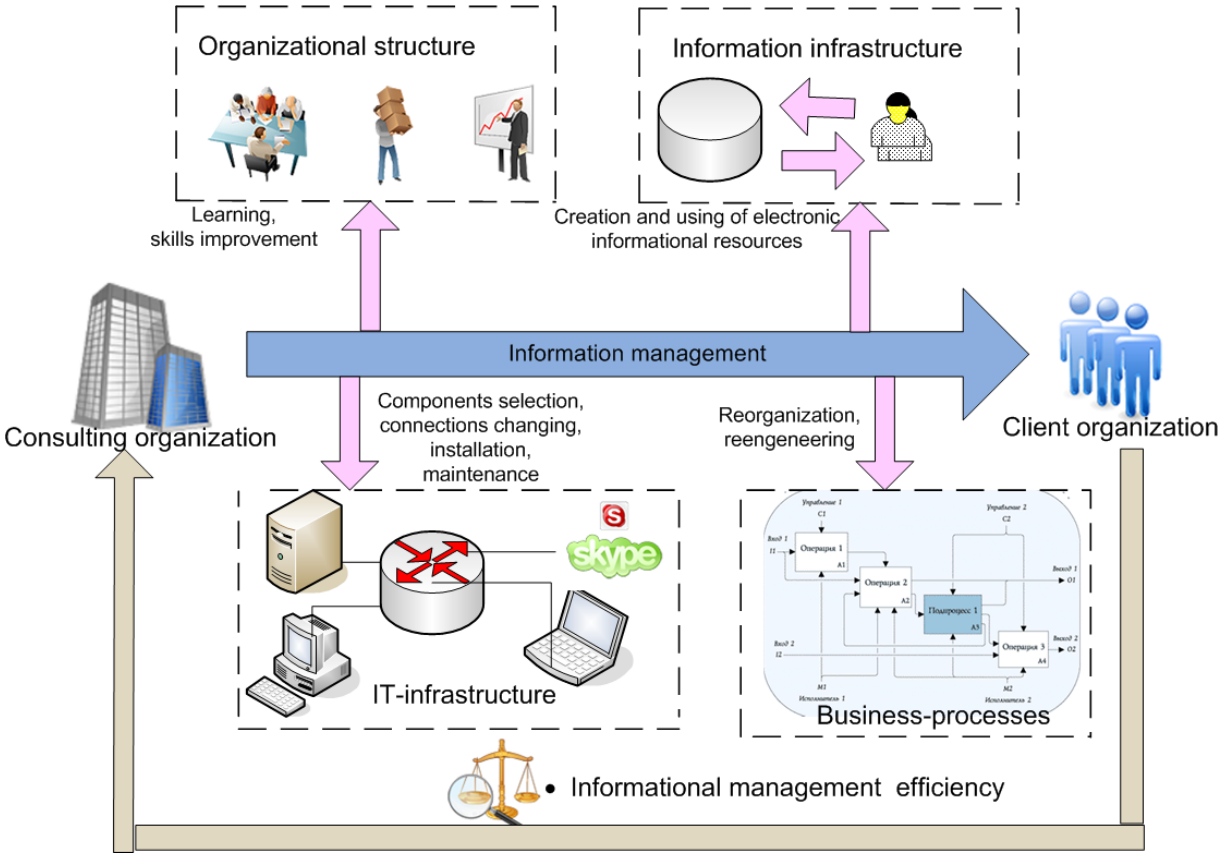

Fig. 1. Constituents of informational management

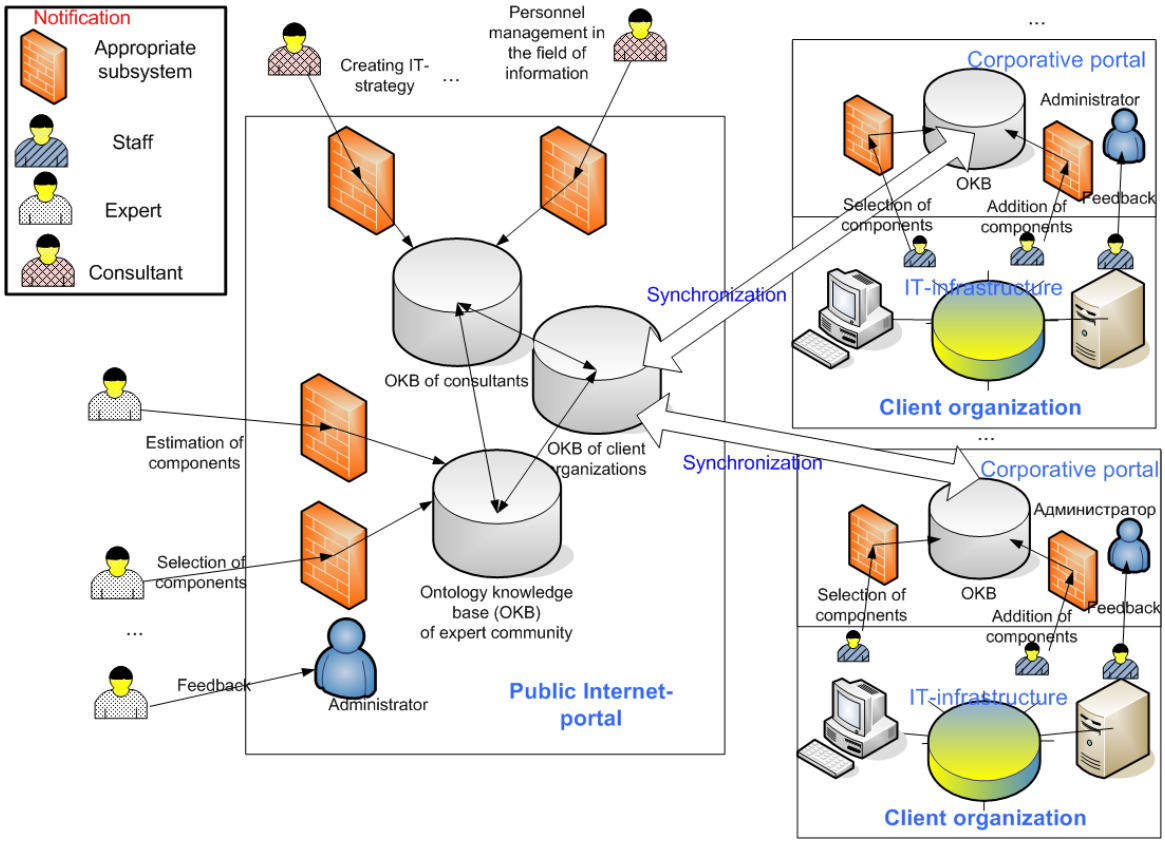

Fig. 2. Common information space

Next we'll specify proposed conception and focus mostly on management of IT-infrastructure's development as a part of IT-consulting, in course of organization's strategy of development, i. e. all changes in ITI should be coordinated with strategy of development. It can be achieved by means of linking components with IT procedures, IT procedures – with business processes, business processes – with business objectivities and finally business objectivities – with enterprise strategy. Also in order to make ITI more efficient it's quite important to take into account staff skills during ITI development. It's necessary to provide informational decision making support to up-grade quality of services of IT-consulting. Dynamic changes of environment of client enterprises, weak structuring of modeling subject domain and capitalization of their knowledge requires elaboration and application of new meanings of decision making support, based on knowledge management. One of the most perspective directions of knowledge management is ontological approach, including modeling of subject domain by the means of building of formal ontologies using description logics. So, in description of ITI should be considered that every component of ITI implements some IT-procedure and used by some person. Keeping this in mind, we elaborated model of representation of IT-infrastructure. Formally IT-infrastructure [3] is represented as four

$$\text{ITI} = <Comp, ITP, Pers, R>,$$

where *Comp* is a finite set of components of ITI; *ITP* – a finite set of existing IT-procedures on enterprise; *Pers* – a finite set of staff of enterprise, realizing IT-procedures from *ITP* by the means of components from Comp; $R = \{R1, R2, R3\}$ – a set of binary relations denoted R_i:

$$Comp \rightarrow Comp \ (i = 1, .., 3),$$

where R_1 is a binary relation of belonging one components to others, e. g., which computer parts belong to computers (personal computers, netbooks etc.); R_2 – a binary relation of components' connection, e. g., description of periphery linking (scanner, printer) with computers, or description of topology of local area network; R_3 – a binary relation of dependence of efficiency of components, for instance, to guarantee efficiency of content management system Joomla 1.5, presence of web-server Apache / IIS, application server PHP and database management system MySQL in ITI is necessary.

Previously formulated conception is specified with the follows abstracts:

- complex examination of client enterprises' IT-infrastructure, as set of subsystems <component, IT-procedure, employee>, is suggested;
- methodology of balanced scorecards by Kaplan–Norton (BSC) is adapted for estimation of quality of IT-consulting services [10].

First thesis is based on the model of ITI's representation. Next one will be described in respective sections.

4. METHOD OF ESTIMATION OF QUALITY OF IT CONSULTING SERVICES

In order to develop method of estimation of quality of IT-consulting services, the Balanced Scoreboard (BSC) approach [10] is applied.

Complex quality coefficient K_{ITC} is calculated as follows:

$$K_{ITC} = k_c K + k_f F + k_p P + k_{pr} Pr, \qquad (1)$$

where K – services' quality coefficient by client constituent; F – services' quality coefficient by financial constituent; P – services' quality coefficient by constituent of IT-consultants' learning and development; Pr – services' quality coefficient by constituent of organization of rendering of services; k_c, k_f, k_p, k_{pr} – weights of constituents respectively, which are defined by decision-maker by means of method of pair comparisons.

Services' quality coefficient by constituent of IT-consultants' learning and development is calculated using formula

$$P = k_{\text{qual}} P_{\text{qual}} + k_{\text{prod}} P_{\text{prod}} + k_{\text{fluc}} P_{\text{fluc}},$$

where P_{qual} – coefficient of accordance of qualification of IT consultants; P_{prod} – coefficient of IT consultants' labour productivity; P_{tech} – fluctuation of IT consultants; k_{qual}, k_{prod}, k_{tech} – weights of coefficients of qualification, labour productivity and fluctuation of IT consultants respectively.

Services' quality coefficient by constituent of organization of rendering of services can be written as follows:

$$Pr = (\tau_1 + \tau_2 + \ldots + \tau_s) / (T_1 + T_2 + \ldots + T_s),$$

where s – amount of stages of project of IT consulting; $\tau_1, \ldots, \tau_s$ – planned schedule times by respective stages; $T_1, T_2, \ldots, T_s$ – real schedule times by respective stages.

Calculation of services' quality coefficient by financial constituent depends on maturity level of client enterprise. Defining maturity level is based on methodic, proposed in [9]. First matrix of concordance between business and IT is built. Then, using matrix, measure of automation M is figured out:

$$S_i = \frac{1}{3K_i}\sum_{j=1}^{K_i} x_{ij}\,,\quad M = \frac{1}{\sum_{i=1}^{N} P_i}\sum_{i=1}^{N} P_i S_i\,. \qquad (2)$$

Respectively [5], if $M < 0.3$, than method of lump-sum costs is used for calculation of services' quality coefficient by financial constituent, if $M > 0.7$, then method of reimbursement of assets, else – model ROI (return of investment), suggested by Gartner Group (see (3)).

$$F = \begin{cases} \dfrac{Output}{Outlay}, & \text{if } M < 0.3, \\ \dfrac{Effect}{TCO}, & \text{if } 0.3 \le M \le 0.7, \\ \dfrac{Fee_{IT}}{Fee_{alt}}, & \text{if } M > 0.7. \end{cases} \qquad (3)$$

Services' quality coefficient by client constituent is calculated using formula

$$K = k_{\text{adm}} K_{\text{adm}} + k_{\text{staff}} K_{\text{staff}}\,,$$

where K_{adm} – level of satisfaction of administration of client enterprise; K_{staff} – level of satisfaction of staff of client enterprise; k_{adm}, k_{staff} – weights of levels of satisfaction of different groups of clients.

K_{adm} и K_{staff} are calculated using adaptation of method SERVQUAL to IT-consulting [11], under which level of satisfaction is examined in complex, by range of some constituents (Reliability, Competence, Empathy, Responsiveness): first clients' questionnaire is implemented by means of questionnaire design, than the results are processed and quantitative level of satisfaction is figured out.

5. ONTOLOGY MODEL OF PROCESS OF IT CONSULTING SERVICE

In the section we briefly describe ontology model in course of proposed conception, which formally is *TBox* [1, p. 13] – block of terminology as description of subject domain (SD) concepts and relations between them (roles). It describes typical business-processes, IT procedures and components of IT infrastructure, hardware and software classes, skills of staff of client enterprises and support gathering information stage and structuring data about objects of consulting in SD. OKB on OWL [2] can be built by means of this ontology model, consisting of *TBox* and *ABox*. Individuals of concrete concepts and relations between them (factology) are represented in *ABox*. We use standard method [7] of knowledge engineering for building of ontology model.

The goals of development of ontology model can be written as follows:

1. To describe common structure of ITI and client enterprise.

2. To couple components of ITI with hierarchy of classes of software and hardware.

3. To link components of ITI with staff and business-processes, according to proposed model of representation.

Example of list of control questions, using for check ontology model's reliability, are the following:

1. To what class of components is subsumed this component?

2. What netbooks do exist in ITI?

3. Who from staff can send faxes using Panasonic KX-FAT88A?

4. What components are the parts of this personal computer?

Now we show and comment some fragments of descriptions of ontology model. Component of hardware or software can be stated as "something, implementing functionality as a set of business-functions":

$$COMPONENT \equiv \forall\ Implements.BF,$$

$$COMPONENT \equiv SOFTWARE \cup HARDWARE$$

To define object role *Implements*, the following construction, defining domain and range of the role, is used:

$$\top \subseteq \forall\, Implements^{-}.COMPONENT,$$
$$\top \subseteq \forall\, Implements.BF.$$

It's quite convenient to constitute role *Implemented* as inversion of the role *Implements*, to define what business functions are implemented:

$$Implemented \equiv Implements^{-}.$$

In turn, software and hardware can be worked out in detail:

$$SOFTWARE \equiv SYSTEM\_SOFTWARE \cup$$
$$\cup\ APPLICATION\_SOFTWARE \cup$$
$$\cup\ DEVELOPMENT\_SOFTWARE,$$
$$HARDWARE \equiv NETWORKING\_EQUIPMENT \cup$$
$$\cup\ PERIPHERY \cup COMPUTER\_COMPONENTS.$$

Relation R_3 can be defined using transitive role Tr (*DependsOn*) and hierarchy of roles:

$$DependsOn \subseteq AttributeOfWare.$$

E.g., the fact that software *MoBill-Interception3.7* depends on multichannel card of computer telephony Olha in OKB stated in this way: *DependsOn*(*MoBill-Interception3.7*, *Olha*).

Components of IT infrastructure from set *Comp* can be defined as follows:

$$COMPONENT\_ITI \equiv \forall\ BelongsITI.ITI.$$

In turn, we can divide concept *COMPONENT_ITI* into parts:

$$COMPONENT\_ITI\ \_SOFT \equiv$$
$$COMPONENT\_ITI \cap$$
$$\cap \forall\ ISCOMPONENT.\ SOFTWARE,$$
$$COMPONENT\_ITI\_HARD \equiv$$
$$COMPONENT\_ITI \cap$$
$$\cap \forall\ ISCOMPONENT.\ SOFTWARE,$$
$$==1\ ISCOMPONENT.$$

It means that component from IT-infrastructure can belongs only to one type of hardware (software), e.g. individual from OKB *component1* can only be *BROWSER* and cannot be something else.

Relation R_1 can be defined using set of roles, for instance, *InstalledOn,* describing that software component in ITI can be installed on one or less hardware component:

$$T \subseteq \forall\ InstalledOn^{-}.COMPONENT\_ITI\ \_SOFT,$$
$$T \subseteq \forall\ InstalledOn.COMPONENT\_ITI\_HARD,$$
$$\leq 1\ InstalledOn.$$

Connection between sets *Comp*, *ITP*, *Pers* from model of representation of ITI can be defined using corresponding roles and concept *SKILL* as mediator:

$$T \subseteq \forall\ HasSkill^{-}.STAFF,\ T \subseteq \forall\ HasSkill.SKILL,$$
$$T \subseteq \forall\ UseComponent^{-}.SKILL,$$
$$T \subseteq \forall\ UseComponent.COMPONENT\_ITI,$$
$$T \subseteq \forall\ ImplementsITP^{-}.SKILL,$$
$$T \subseteq \forall\ ImplementsITP.IT\text{-}PROCEDURE.$$

Connection between business-process and set of IT-procedures can be stated as follows:

$$T \subseteq \forall\ Executed^{-}.BUSINESS\text{-}PROCESS,$$
$$T \subseteq \forall\ Executed.IT\text{-}PROCEDURE.$$

We define satisfaction by means of inviduals enumeration:

$$SATISFABILITY = \{responsiveness,$$
$$reliability, empathy, competence\}.$$

Ontology model has been extended with decision making rules and implemented on SWRL (Semantic Web Rule Language); some examples are represented in Table 1. The results of decisions are formed as concepts or roles (consequent in rule on SWRL), which output to decision-maker, e. g., as list of components to eliminate. Some of these rules are subsidiary, some – contain management decisions. In first rule *swrlb* is namespace (http://www.w3.org/2003/11/swrlb#) for application of builtin rules (i. e. various functions, e. g., for comparison between integer values). In second concept *NOTAUTOMATED_BP* is defined as follows:

$$NOTAUTOMATED\_BP \equiv BUSINESS\text{-}PROCESS$$
$$\cap \neg \exists\ Executed.IT\text{-}PROCEDURE.$$

Table 1. Examples of decision rules for IT-consulting

Decision making rules on SWRL	Description on natural language
Delete(?ware2)← *IsComponent*(?comp_iti1, ?comp1) ∧ *IsComponent* (?comp_iti2, ?comp2) ∧ *Implements* (?comp1, ?bf1) ∧ *Implements* (?comp2, ?bf1) ∧ *Profitability*(?comp_iti1,?r1) ∧ *Profitability*(?comp_iti2,?r2) ∧ swrlb:greaterThan(?r1, ?r2)	Delete component of IT-infrastructure, if other component in IT-infrastructure exists, implementing the same functionality and more profitable.
AUTOMATE(?bp) ← *NOTAUTOMATED_BP* (?bp)	Automate business-process, if it's not automated.
Assign(?p,?comp_iti) ← *HasSkill*(?p, ?skill) ∧ *ImplementsITP*(?skill, ?itp) ∧ *UseComponent*(?skill, ?comp) ∧ *IsComponent* (?comp_iti, ?comp) ∧*FREE_COMPONENT_ITI*(?comp_iti)	Assign employee ?p component of IT-infrastructure according to his skills for IT-procedure execution.
BUSY_COMPONENT_ITI(?comp_iti) ← *Assign*(?p,?comp_iti)	If component of IT-infrastructure is assigned to an employee, than it becomes busy.
BUY(?comp)←*Implements*(?comp, ?bf1) ∧ *HasFunctionality*(?itp, ?bf1) ∧ *HasSkill*(?p, ?skill) ∧ *ImplementsITP* (?skill, ?itp) ∧ *UseComponent*(?skill, ?comp) ∧ *Executes* (?itp, ?bp) ∧ *NOTAUTOMATED_BP* (?bp) ∧ *Implements* (?comp, ?bf2) ∧ *Implements* (?comp, ?bf3) ∧ … ∧ *Implements* (?comp, ?bfN)	Buy component to automate business-process, according to employees' desires as set of business-functions. Necessary components search is assumed.
ATTEND(?sat1) ← *SATISFABILITY* (?sat1) ∧ *SATISFABILITY_PREV*(?sat2) ∧ *Level*(?sat1,?lev1) ∧ *Level*(?sat2, ?lev2) ∧ swrlb:greaterThan(?lev2, ?lev1)	Pay more attention on ?sat. For example, if ?sat=reliability, consultants should attend accuracy and reliability of rendering of services.

4. CONCLUSION

In the paper management consulting in the field of information management is investigated. Briefly the main results of investigation are listed below:

- specificity of services of management consulting is analyzed;
- conception of common information space is proposed and specified for IT-consulting;
- method of estimation of quality of IT consulting services is developed. It allows estimating services' quality complexly, taking into account several constituents;
- ontology model, describing typical business-processes, IT procedures and components of IT infrastructure, hardware and software classes, skills of staff of client enterprises for support of gathering information stage and structuring data about objects of consulting, is developed.

ACKNOWLEDGMENTS

This investigation is supported by the grant 12-07-00377-a of Russian Foundation for Basic Research, the research work has been performed within the state work on theme 8.1224.2011 «Development of software tools support decision-making for different kind of management activity in industry in the conditions of semistructured data based on the technology of distributed artificial intelligence».

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