

CERTAIN APPROACH TO BUILD AN INNOVATIVE EDUCATIONAL PROCESS

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ABSTRACT

For the last 5 years the market of intellectual capital has dramatically decreased, the graduating students' knowledge quality steadily decreases and the ambitions for the fee increase. This article describes the application of currently most promising methods of (1) network (graph) theory, (2) data mining and (3) subject-oriented approach to business process modelling for creating and automation of innovative process and therefore for maximization of ROI (return on investments) in universities intellectual and social capital. Described approach represents the High School activity as the knowledge-made process, reveals students, capable of innovation activity for their further deep study of innovation practice, transfers the moment of novation forming with further discussion the possibility of novation realization as an innovation into the educational process, develops maximum person-independent procedures of innovation work groups forming and expert communities for evaluation of both novations and innovation budgets. The given research was held in a frame of the contract № 13.G25.31.0096 with the Ministry for Education and Science of Russian Federation «Creation of hi-tech manufacture of unstructured information processing in cross-platform system on the open-source software basis in order to increase management efficiency of innovative activity of enterprises in modern Russia».

In fast-changing market conditions ability to innovative activity with the subsequent generating of innovations and their approbation is the most demanded in business environment. In this regard it is possible to allocate tendency to demand of specialists-innovators having in their arsenal ideas and developments, with the subsequent commercialization of innovations. This article is devoted to managerial aspects of intellectual capital including expertise search in set subject domain for creation of economic value in the form of innovations, management of intellectual assets and the human capital. It is related to knowledge management, but emphasizes the valuation and productive employment of intellectual capital and the innovative process support.

At present realization of this process is so-called policy of open innovations within which there are marketing researches of consumers, best practices loans, search and purchase of intellectual property, investment in basic scientific researches etc. The main problem which the companies in the market of intellectual capital face is that this market over the last 5 years was sharply reduced due to decrease in higher school graduate's knowledge quality. In this regard discussion on necessity of conditions generation for formation of knowledge economics and/or innovations became one of the mass media main subjects. This trend is observed in all countries of Europe and America, however, the transition model still isn't chosen. In compliance with the Global Innovative Index on investments into innovations Switzerland, Singapore and the USA are on 1 place, Great Britain – on the 5th, Japan – on the 6th place, China – on the 8th place, Russia – on the 32nd place [1]. Further the main problems of innovative processes management in the developed countries, particularly in Russia, will be allocated.

MAIN PROBLEMS IN EDUCATIONAL PROCESS

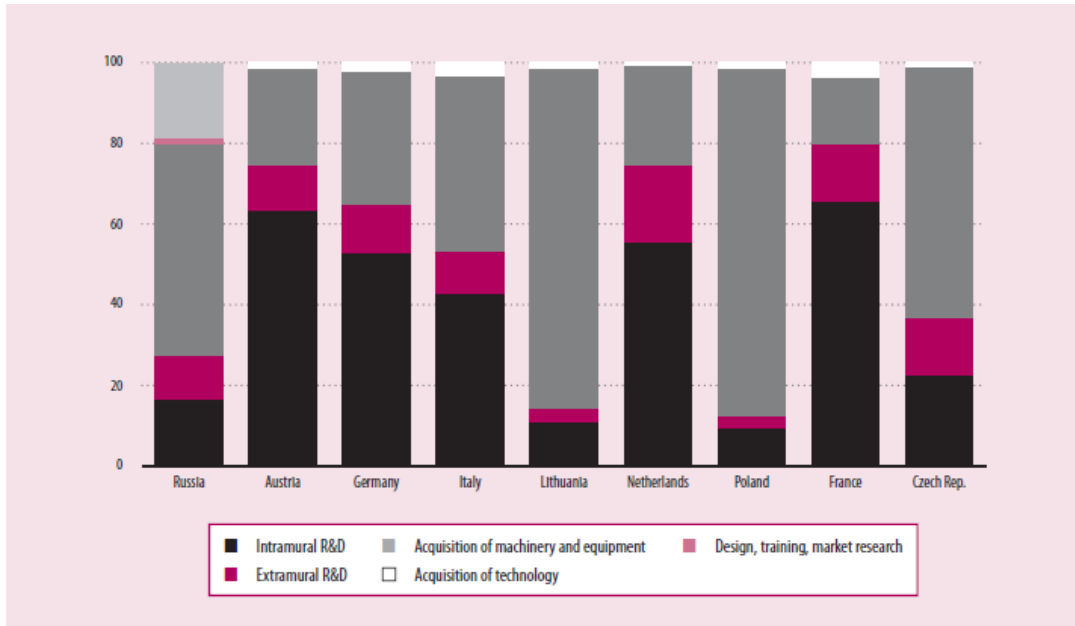
In the last decades in high- and middle-income countries alike, various national strategies have aimed to improve the linkages between the various innovation actors, most notably the science system and higher education. The main problem of education system in Russia is the lack of interactions among innovation actors—firms, the public sector, academia, and society—in modern innovation ecosystems. In the last WIPO report emphasis is put on the increasingly collaborative nature of innovative processes. Such collaboration has been facilitated as innovation processes have become more fragmented and ‘open’ [2].

The measurement agenda has evolved to address the systemic dimension of innovation—that is, the activities of multiple innovation actors and linkages among them [3].

Over the last two decades, the Russian Federation has completed its integration into global chains of production and knowledge flows has become more established and has deepened along with the country’s economic and social changes. However the percentage of innovative enterprises has not exceeded 10–11% since 2000 (Source: Eurostat). The poor aggregate performance of the national innovation system is explained by a number of structural and institutional imbalances—the innovation cleavages that diminish synergetic effects and discourage innovation-based growth. The first problem is science-industry split-offs due to technology adoption via acquisition of machinery and equipment. The second problem is a traditional institutional model of the R&D sector that still retains the Soviet institutional model in terms of its organizational structure and state participation. Because of the deterioration of R&D activities at some public higher education establishments and the rapid growth of a respective private network during the last two decades, only 45% of universities are involved in R&D. The gap between science and education has been affecting the quality of teaching staff and educational programs, and hampers the competitiveness of university graduates in the labor market (see fig. 1).

Unfortunately, all the above-mentioned leads to a conclusion that the education system isn’t focused on generation of innovative approaches to the solution of tasks due to absence of structural understanding/vision of knowledge - forming processes and an innovative ecosystem. From here it is possible to come to a conclusion that the uniform information environment or the innovative process generating new elements on creation of an innovative product, demanded by the market should unite subjects of innovative activity. Only in this case subjects of innovative activity (students, professor, venture funds, the companies, R&D, universities and research laboratories) will have the debugged process of innovations commercialization.

Fig 1. Expenditure on technological innovation in industry by innovative activity, % (Sources: HSE, 2011; Eurostat, 2008.)



The moment of student arrival to university should become an initial event of this process. Such early beginning is explained by the fact that the average period of various psychometry measurements of innovations generation after education makes 10 years, and the average quantity of students that are being trained and are capable to innovative activity - about 10 % from total number of students. However, in 10 years no more than 1 % of graduates participates in innovative practice, the others "are lost" in 10 years. This trend can be broken only if including students in innovative process, thus, transferring the innovation formation moment to educational process with the subsequent consideration of possibility of innovation realization as an innovation. In this case the critical mass of talented students-innovators leading to origin of innovations will be saved up in system.

INNOVATIVE EDUCATIONAL PROCESS

In the course of innovations generation it is possible to allocate seven phases, corresponding to life cycle of innovation from its origin in the form of innovation to a routinization and obsolescence:

- 1) Fundamental research
- 2) Basic technology research
- 3) Applied technology research
- 4) Primary introduction. Industrial development
- 5) Innovation diffusion
- 6) Deployment
- 7) Innovations obsolescence

The challenge is to develop effective academia-enterprise innovation linkages in this innovative process. In this case students within universities participate in fundamental scientific development which solid drawn transfer then in the form of knowledge

(innovations) to a business environment for their subsequent distribution. There are two main objectives: encouraging the commercialization of research and promoting technology transfer from universities and research institutes.

Thus, the high-quality changes occurring in educational process can become a challenge for changing of all structure of innovative activity in purposeful knowledge - forming process on support of students innovative activity for their further profound studying of innovative practice. All this will lead to development of the most person-independent procedures of the innovative working groups and expert communities formation for estimation of innovations, and innovative budgets.

RESEARCH QUESTION 1

One of the important directions of creative and innovative management development is the development of conditions diagnostics methods for exploitation of employees creative potential in organization innovative activity. Foreign and domestic researches revealed several dozens of factors activating or slowing down innovative activity of the companies and the organizations: managerial susceptibility to new ideas, tolerance to risk, support of new ideas, relations in collective, existence of necessary resources etc.

Due to changes introduction in already settled companies employees are inclined to show passive position of observers of innovative process, the so-called «comfort zone» which kills new ideas and general possibility of their emergence and further realization is created.

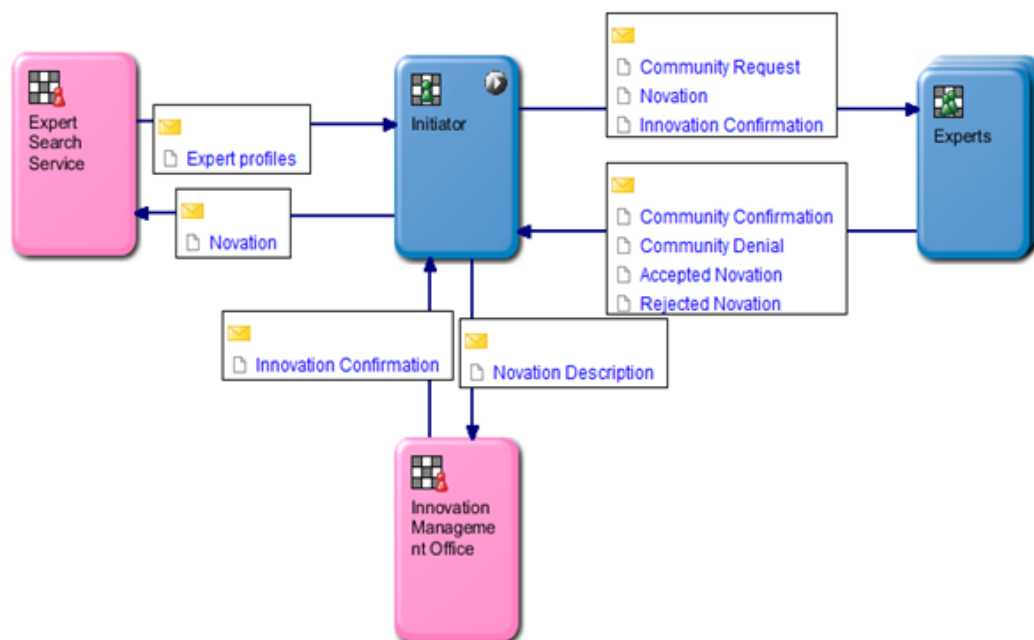
Subject-oriented approach is a new paradigm of business process modeling. This method allows to illuminate and incorporate the true participants of the business activity while modeling the processes and to adopt their understanding of their roles and responsibilities to the real productive system. This approach allows to "include" activity of the students and teachers participating in debugging and introduction of innovative educational processes, to use reflexivity for changes and to introduce models by the same people who carry out these processes later. Thus, employees are motivated by their individual contribution of expertize transfer from one employee to another.

Thesis 1: the innovative system should possess ability to support interaction between innovators and experts for carrying out expertise of an innovation.

Thesis 2: The most expedient way of creation and automation of innovative process is application of subject-oriented approach to innovative process management. In such case there are all necessary conditions for realization process and network communities ad hoc and also for brightest development of reflection while creating new knowledge.

For specification of above-mentioned theses let's consider how S-BPM realization in tool system Metasonic (former jCOM1) S-BPM Suite looks like.

Fig. 2. Example of describing an interaction of actors in the subject-oriented model of the Innovation Process Management (S-BPM point of view)



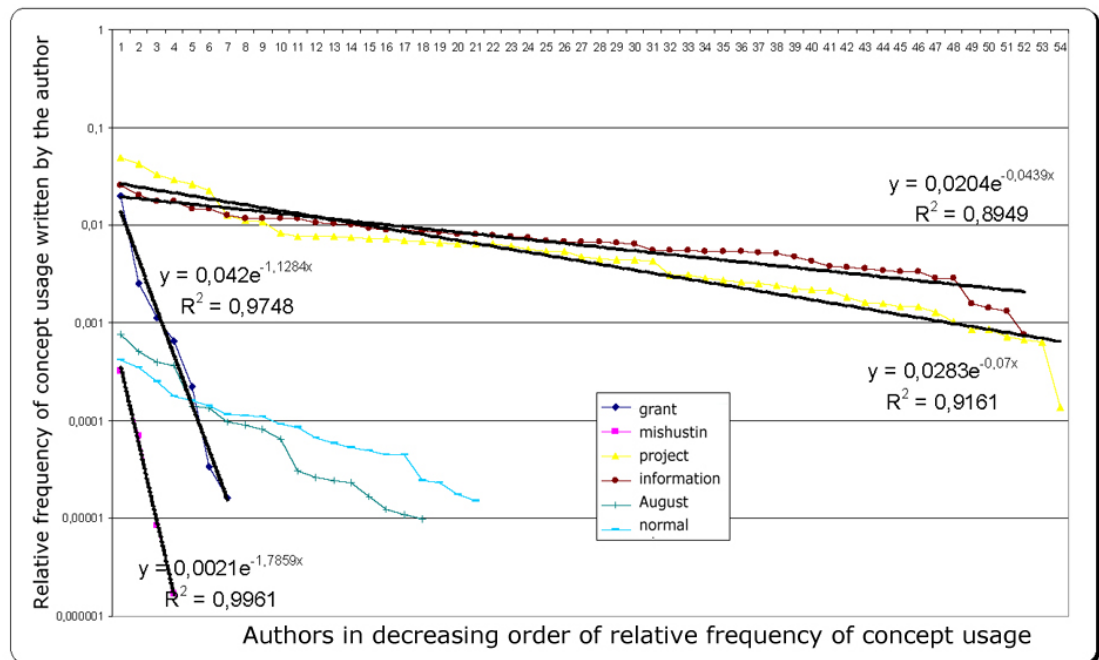
The model of innovative process in «Process Manager» is designed in such a manner that the subject "Initiator" (the founder of innovation) sends the message "Innovation" to the subject «Experts Search Service» (it not the person but the element of system which is processing information). «Experts Search Service» possesses profiles of enterprise staff, in reply to the demand sends the message to the initiator with candidates of potential investors of intellectual capital and their profiles. Having analyzed recommendations and profiles of candidates initiator sends the invitation to potential investors «Request for Community Creation» and receives approbation «Confirmation of Accidence to Community» or denial. The new community for innovation development is automatically created where all experts who have accepted the inquiry take part. Afterwards, the innovation discussion process will occur in expert's community. The potential investor and experts turn into participants of innovative process. After accumulation of intellectual investments of all community participant's development of innovation takes place. Corresponding innovative process is a peculiar basis for creation of the innovative environment in higher education institution, after all when in it there exist necessary "incubators" where innovations will arise and develop, it is clear to students where and how to address with their ideas. As a result, virtual community with a multiple content centers is created presenting a prototype of intellectual neural network with distributed association nodes. These nodes are formed during non-standard educational process similar to brainstorming where participants have quite different knowledge levels and limitation due to 'traditional thinking', for example, classical seminar in auditorium in parallel with webinar. .

RESEARCH QUESTION 2

The second question mentioned in this work is experts search within universities. Experts are people who are able to satisfy certain information needs, give correct answers to specific questions, explain them and even guide the user further to other sources of relevant information. The need in finding a well-informed person may be critical for any kind of

research. A practically usable expert finder should help not only to identify knowledgeable people, but also to select the most appropriate experts among them for a face-to-face contact [4]. However, any attempt to identify experts by manual browsing through organizational documents may fail in very large universities, especially when they are geographically distributed. An automatic expert finder uses a user query as an input and returns a list of persons sorted by their level of knowledge on the query topic. It is possible to assume that significant terms should have strong non-uniform distribution of relative frequency of usage among employees, and common ones – approximately identical relative frequency of usage. Let's construct similar dependences in double logarithmic scale for various terms (see fig. 3) chosen from the employees texts:

Fig. 3 Dependence of relative frequency of term usage written by the author from rank in double logarithmic scale



It is intuitively clear that such terms as "grant" and «mishustin» are significant so "grant" is the specific term of subject domain, «mishustin» is the proper noun; both of them are notional in narrow range of experts. Terms "project" and "information" are common in the chosen subject domain because probability of its utilization by each enterprise employee is approximately the same. Analyzing the diagram it is visible that for significant words and general meaning words the distribution character differs, namely dispersion in observable distribution of relative frequencies of terms usage.

In consequence of the experiment, it is possible to draw conclusion that exactly higher values of dispersion of relative frequency of term usage is that criterion which allows distinguishing significant terms from the common ones. It has to be mentioned that on the basis of dispersion calculation of relative frequency distribution of terms occurrence algorithm it is possible to reveal experts for program service of intra corporate experts search

which is based on texts analysis. This analysis is used for formation of limited list of employees (experts) working at the enterprise who are most competent in this or that question. On the basis of expert's lists the intra corporate expert network is formed (see fig. 4).

Fig. 4 Expert search service

Поиск экспертов (тестовая оболочка), версия 0.3, база MySQL 172.30.0.73:3306\BR5

6.1.18.1. При разработке ЕГИСМ должны быть применены результаты научно-исследовательских работ (НИР) «Разработка методических основ формирования и ведения Единой базы диссертаций и авторефератов диссертаций в электронном виде в обеспечение приоритетных направлений развития науки и технологий» выполняемых в 2010 – 2011 гг. в рамках Государственного контракта от 20 октября 2010 г. № 04.521.11.1004, в т.ч.:

- 1) Результаты анализа и систематизации информации о диссертациях и авторефератах диссертаций, представленных в ВАК.
- 2) Результаты анализа методического обеспечения и состава аппаратно-программных комплексов и средств формирования и ведения учета диссертаций и авторефератов диссертаций ВАК.

Сотрудник	Ранг
МИРОШКИН СЕРГЕЙ ВАСИЛЬЕВИЧ	159,072525
ВИНОГРАДОВ ВАЛЕРИЙ НИКОЛАЕВИЧ	131,6534
ПАНЧОЯН АРТУР ВАЛЕРЬЕВИЧ	129,687164
СОЛОВЬЕВА СВЕТАНА ВИТАЛЬЕВНА	124,641663
ПЛАТОНОВ ЛЕОНИД ПЕТРОВИЧ	119,995361
НИГМАТУЛЛИН СЕРГЕЙ ХАЛИТОВИЧ	119,616028
КУДРЯВЦЕВ БОРИС ГРИГОРЬЕВИЧ	93,10083
ГАЛКИНА ОЛЬГА АНАТОЛЬЕВНА	91,75338
ОДЕГОВА ЕЛЕНА ДМИТРИЕВНА	83,62063
ЕВГРАФОВ ЕВГЕНИЙ ВЕНИАМИНОВИЧ	81,7484741
ФЕДОСЕЕНКОВА АЛИНА ОЛЕГОВНА	79,2841339
ПЕТРОВ МИХАИЛ ФЕДОРОВИЧ	73,2015839
ПРОКУДИН АРКАДИЙ ВЛАДИМИРОВИЧ	71,7905045
ДОБРОТИНА МАРГАРИТА ЮРЬЕВНА	70,15682
ФОКИНА ЛИДИЯ ГЕННАДЬЕВНА	69,70469
МИРОНОВ АЛЕКСАНДР БОРИСОВИЧ	68,44239
ИНИХОВА МАРИНА АЛЕКСАНДРОВНА	67,9763947
ЛЕВАШОВ АЛЕКСАНДР МИХАЙЛОВИЧ	67,0493
ВЕЛИЖАНИН АЛЕКСАНДР СЕРГЕЕВИЧ	67,0329742
КАЗМИРЧУК ДМИТРИЙ НИКОЛАЕВИЧ	66,92469
БАРАНОВА ЛАРИСА АНДРЕЕВНА	65,63895
МАТЭ АЛЕКСАНДР ЛЕОНИДОВИЧ	65,0621643
ПАВЛЮЧЕНКО МАКСИМ НИКОЛАЕВИЧ	64,5944443
ОБОДОВА СВЕТАНА ЮРЬЕВНА	64,59239

наполнил термов 31306
Ранг 159,0725 = 206,2946*0,7 + 146662,9*0,0001 + 0*0,1
Коэффициент прямой связи 206,2946 = сумма[
Термы запроса

Терм	Значимост	Связь с персонами
ГОСУДАРСТВЕННЫЙ	0,883772	5,72031
КОНТРАКТ	1,13491	5,20401
АНАЛИЗ	0,800036	3,71357
СИСТЕМАТИЗАЦИЯ	1,79586	1,38629
ИНФОРМАЦИЯ	0,333863	5,31812
ПРЕДСТАВЛЕННЫЙ	0,879487	2,70805
ВАК	3,47438	3,89182
СОСТАВ	0,572038	4,61512
АППАРАТНЫЙ	0,899968	2,07944
ПРОГРАММНЫЙ	0,550172	4,61512
КОМПЛЕКС	0,775309	2,94444

Термы, расширяющие текущий терм

Терм	Значим	С с	С с
ЕГИСМ	2,768...	6...	1...
ПРОЕКТ	0,398...	4...	1...
СОВЕЩАНИЕ	1,178...	3...	8...
ЕГИС	4,470...	2...	8...
ДИССЕРТАЦИЯ	5,169...	5...	7...
ТЕМА	0,385...	3...	7...
СИСТЕМА ЭЛЕКТРОННОГ...	1,740...	1...	7...
ПРЕДВАРИТЕЛЬНЫЙ	0,548...	3...	7...
РЕАЛИЗАЦИЯ	0,581...	4...	7...

However, receiving one assessed value on dispersion might not be enough in order to getting stable result. On this figure the dispersion value for words "august" and "normal" are approximately equal but are they displaced towards "significant" ones. Whether this means that they should be defined as concepts for the narrow range of experts, categorically "no" as these concepts were allocated at the expense of discussion of the holidays season and conditions of its carrying out (so-called social factor).

The following algorithm allows to essentially extend definition of expert distribution and to clarify its specifics. Using expert-determined taxonomies for concrete "closeness" processes definition of each specific employee to these distributions by calculating percent of words belonging to taxonomy, from total number of used words employed by the employee, finally, we will receive the distribution vector of personal "closeness" of each employee concerning all (or allocated) processes in corporation. It is note-worthy, that this representation won't be static or constant, moreover, it is possible to judge adaptability of the specific employee or change of his personal ambitions, interests etc. from speed of its change.

An expert search algorithm aims to assess and access "tacit knowledge" in organizations by finding a way to it through artifacts of "explicit knowledge". It analyzes

organizational documents in order to find some evidence about the expertise. The list of terms relevant to expert finding research is shown for each expert (see fig. 4).

RESEARCH QUESTION 3

The availability and interruptibility of experts that may depend on their location and/or workload should be considered. Second, it must estimate communication skills of persons along with their expertise. The knowledge exchange is often hardly reachable due to cultural or language differences, or due to lack of communication and presentation skills of an expert. An expert finder should also try to predict whether the communication is likely to be desired by both parts. Preferences of experts and users on communication with certain people (e.g. based on their positions/ranks or reputation in a company) should also be integrated. Most of the abovementioned issues are the topic of the dedicated research on pervasive and ubiquitous computing, assuming that personal context can be inferred from measurements made by sensors of various types [5].

This research topic is expert's social capital measurement in intra corporate expert network for employees ranking. Methodological base of research are provisions of modern theory of networks, mathematical linguistics, sociology and psychology. Communications can be presented in form of social system described by means of graph $G = (V, E)$ where set of V-tops represent employees, and set of E-edges represent connections between employees expressed in their communications with each other.

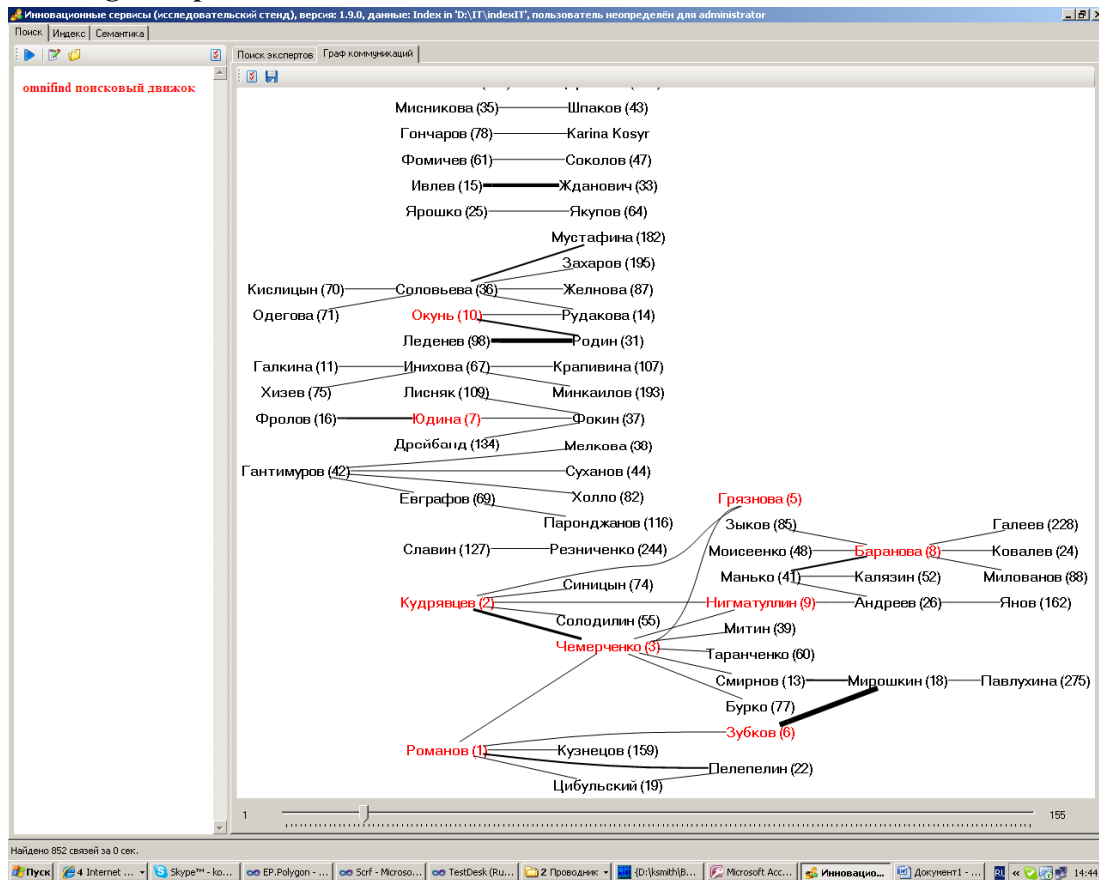
Messages exchange among employees can be presented as network structure of interaction – as bigraph. Positioning isn't satisfied by spatial distance. Any position of individual in network is defined by its relations to other positions.

In order to measure social capital it is offered to calculate indicators of nodes centrality. Centrality – is indication of how high is the employees social capital, it is based on number of its communications with other network nodes (see fig. 4).

There are three main indicators of centrality:

- Betweenness – shows what influence the node has for connection of gaps between other nodes in network. If network is designed in such a manner that there are no other ways of interaction of other nodes except through this node, it will have the maximum influence. Removal of node which has big betweenness indicator will cause break of information flow and will lead to network [6] fragmentation. Such nodes act as brokers or doorkeepers as they supervise information flows [7].
- Closeness shows possibility of fast access to information; it is inversion of sum of the shortest distances between each node and each different node in network. The fewer the intermediary nodes between the current node and other nodes, the lower is the closeness indicator and the higher is the closeness degree[8]. This position is quite advantageous at communications implementation.
- Centrality degree – this characteristic shows who the most active node in network is. In compliance with networks theory a large number of interactions of node might not only change node position in network but also change positions of other nodes. The individual indicator of centrality shows, in what degree the node is connected by other nodes, that is how closely it is connected with the group [9].

- Centrality as indicator of centrality of own vector (eigenvector centrality) — nod importance in network [10]. The indicator estimates relative measures for all nodes inside network based on to whom nod neighbors have connection.
- Clustering coefficient [11] - degree of nodes connectivity in network. This coefficient characterizes tendency to formation of interconnected nodes groups, so-called cliques.

Fig. 4 Expert net

CONCLUSION

Novelty of the current research lies in creating means for automatic detection of person who is an expert in what area, effective search of such expertise, informing who from the identified experts is in network and presenting means of communication with him. All this will allow strengthening and accelerating innovative processes in organizations at the expense of favorable information environment creation that simplifies information exchange between employees and allows accumulation, generalization and classification of advanced knowledge.

Quantity of efforts, which have to be made in order to organize innovative process in organization depends on number of factors, such as organization size, automation level, force of social communications in organization and etc. The developed service can be applied as the tool to the solution of experts search problems on corporate portals, in ECM – system and in any other IS accumulating publications data of process members.

ACKNOWLEDGEMENTS

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