

Use of Information and Communication Technologies for Support of Russian Universities Relations (on the Caspian Region Example)

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Abstract

On the example of Russian Caspian regions authors are considered conditions of universities activities, including features of the competition and cooperation with other organizations. In this article are probed opportunities and restrictions of information-communication technologies (ICT) use for creation and application of universities information systems; for support of universities interaction with their branches, representations, external organizations; for educational process and scientific activities; for implementations of data handling technologies and receiving statistics about universities activities, their communications with the external organizations; for support of universities websites. Models of "efforts" optimal distribution between different directions are offered. Authors are shown the websites role in universities competitiveness ensuring. It is justified that multilingual websites sharply improves probability output of links in case of requests to search engines on not-Russian languages. In relation to websites of universities in Russian Caspian regions are considered questions of languages composition choice; foreign-language contents; means of switching between languages; technologies of websites integration with Internet translators. The paper justifies feasibility of creation and use of joint banks of methodical, training, control and testing materials, within interuniversity associations activities; development of technologies and the control software for access to materials in such banks; support of their information security. Authors are probe possibilities of ICT use for creation of "scientific technological frameworks"; support of processes of researchers groups "self-organization" and their activities; for "platforms" ensuring interuniversity projects execution usage. Also are analyzed the conceptual and technological questions of information security support for universities scientific activities.

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1 Introduction

There are very large number of publications, devoted to different aspects of universities activities, including in their countries and international relations – for example [Hem06, Rod16]. Let's specially note some works which are specially devoted to the universities in Russian Caspian regions [Bil12] or the foreign Caspian countries [Sap13]. In this articles authors are set and decide different tasks of the analysis and support of effective management for universities activities taking into account such factors: competition between universities [Bra14]; need of new types of information-communication technologies (ICT) use [Don12]; need of objective assessment of informatization levels of the universities [Zho18]; different restrictions connected with informatization processes in universities – including on available resources; uncertainty factors; different types of risks. In the modern conditions use of the ICT is the most important means of support of universities activities by different directions [Bat11]. One of them is support of universities information communications with an external environment, including other universities, other types of organizations. These questions are also considered in a number of works. However it is essential that for universities with a miscellaneous "legal status" and different spatial layout in the territories of the respective countries the nature of interactions with an external environment has certain specific peculiarities. These peculiarities in literature are probed insufficiently fully.

Therefore in this article questions of ICT usage for support of contacts with an external environment are probed on the example of Russian Caspian regions universities. They are situated in Republics of Dagestan and Kalmykia, in Astrakhan region.

The general features of the activities conditions for the universities, which are working in the specified regions: existence in this regions of both the budgetary and commercial educational organizations, including branches and representative offices of universities from another Russian city's of; activities of different research and development organizations, including institutional and academic; the considerable amounts of students, trained on the commercial basis in most budgetary universities; different institutional subordination of the universities, working in the considered regions; absence in the considered regions of the universities, having the status of "national research" or the "federal" (in other words local universities should be regarded as "regional"); rather high level of ICT-competence of the population and different types of organizations [Kuz12, Kuz14].

Let's mark also that in the specified regions the leading universities of Moscow and St. Petersburg carry out the active work on selection of candidates for training in a bachelor degree and a magistracy. It leads to outflow from the considered regions of the most "strong" entrants and "potential undergraduates". Recently for the decision of the last task internal rounds of the All-Russian Olympiad "I Am a Professional" began to be used. Its first tours on all disciplines take place in the distant form – on the basis of ICT usage. Thus, there is a lowering of intellectual potential of the considered regions and, as a result, opportunities deterioration of their social and economic development. Competitive advantages of leading universities from Moscow and St. Petersburg: they have considerably great opportunities (in comparison with "regional" universities) concerning scholarship support of bachelors and undergraduates; of the postgraduate studies training continuation; for involvement of students to commercial researchers; for sending students in other countries for temporary training and so forth.

We will refer the following to specific features of the universities considered in this article: the border nature of all three Russian regions and, as a result, their active involvement in development of international relations of the country, support of cross-border transportations of different loads, including multimodal transportations; need of communications development with universities of other countries, adjoining the Caspian Sea (first of all in those regions of foreign countries, which border to this Sea). For the Astrakhan region and, especially, the Republic of Dagestan, we will also mark as specific feature multiethnic and polyconfessional nature of their population. These factors should be considered during the planning and implementation of activity of universities in Internet space, development of their electronic communications [Ser17].

Let's list the main types of competitors of the "regional" budgetary universities from the considered regions. (1) The "regional" commercial universities in this regions and local divisions of the universities from other regions. However this types of organizations realize training of students mainly at the level of a bachelor degree and is

almost exceptional by the humanitarian directions. (2) Other budgetary universities in the same regions. The intraregional competition of universities is escalated by release abbreviation from schools and average special educational institutions; the insufficient number of places in dormitories of the regional budgetary universities – that restricts their possibilities of attraction students from regional rural areas, from the other cities. Comfortable places in university dormitories are necessary also for the following purposes: attraction on training of foreign students and postgraduates from the developed countries; exchange with the foreign universities of students trainees, teachers, etc. Note that commercial universities usually not have any dormitories. (3) The Russian universities in other regions, including Moscow and San Petersburg, the “national research universities”, the “federal universities”.

These universities can attract students on resident training (with departure out of regional borders) or to use distance learning – on the basis of ICT-usage. The distant form is rather popular tool of e-learning in Russia and other countries [Ber12]. (4) Foreign universities. Number of students from the considered three Russian regions, which leave for full-time courses to universities of foreign countries, is now relatively small. Therefore the foreign universities can not be considered as competitors for training at least of bachelors. However in a number of the magistracy training directions (for example on ICT) a situation is different. Some European countries universities offer (on the competitive basis) the places even with “a full grants”; accept for consideration the applications for training in a magistracy submitted by foreign students via the university websites. In the conditions of wide Internet use this information for most of students is well known; they are taken it into account when further training options consideration. (5) Some other types of the organizations – first of all scientific research institutes. Development of ICT aggravates competitive processes by paragraphs “1...4”, including due to use for this purpose the websites of universities; systems of e-mail, contextual advertising; application of electronic repositories of scientific and scientific-technical information and so forth.

In turn Russian universities in the considered three Russian Caspian regions try to attract on training students from other regions of Russia and also from abroad. This is the important direction for universities to receiving income in competitive conditions of their activities [Car16, Kov15, Stu15]. For universities of the Astrakhan region we will note, in particular, a significant amount of students from Kazakhstan, Turkmenistan, developing countries from far abroad.

Universities from Caspian regions of Russia have the defined “climatic advantages” before other Russian educational organizations – at least, before universities of Moscow and St. Petersburg. These advantages are most essential to students from the countries of Africa, Asia, Latin America. Besides, general price level in the considered Caspian regions is lower, than in the majority of other large cities of Russia.

The main directions of the universities competition in the considered regions. (1) For the studying students – bachelors and masters. Concerning this direction is of great importance “competitive investigation” – mainly by the analysis of rival universities websites contents; use of universities own websites for information placement and distribution; holding the olympiads and other competitions for involvement of students – including in the distant form via the Internet. In some cases in “adjacent” regional universities students training on similar specialties is carried out – especially if the budgetary universities have different institutional subordination. Let’s specially mark that in three foreign Caspian states (from four) schools graduates usually adequately know Russian language. It allows them to admit in the Russian universities in the majority of the training directions without use of preparatory divisions. (2) For training of graduate students and doctoral candidates. Objectively “regional” universities have smaller opportunities (comparing with the leading universities of Russia) for graduate students support with scientific principals. (3) For teachers of universities – in this case it is mainly the intraregional competition. Let’s mark also that a part of teachers can work at the same time in several regional universities, including commercial. For lecturing, training, master classes carrying out and so forth also teachers from the outside of regions, including from abroad, can be attracted on limited time. Carrying out of non-residents (including foreign) teachers in the distant form is relatively poor used by the universities in Caspian regions. In too time the modern ICT allow to make it sufficiently effective. To some extent involvement of foreign teachers restrains also by insufficiently good English knowledge of the considered regional universities students – especially on low courses. In this regard we will mark that owing to border layout of three Russian Caspian regions in their universities, pay the considerable attention to a study by students-bachelors of the “second” foreign languages. For example, at the Astrakhan state university many students are learned as “second language” Chinese, Korean, Farsi and some others “eastern” languages.

Note that the intraregional competition of universities “for teachers and research associates” can take place not only with the research and development organizations, but also with commercial. Such organizations can often offer the best terms of work payment in the comparison with regional universities. In too time the “interregional”

competition of the Russian universities for staff teachers is less important – owing to high saturation of the Russian market by teachers with academic degrees and ranks; low "labor mobility" of universities teachers and so on. (4) The competition for receiving "federal" grants for carrying out scientific research and so forth. For Russia it is mainly grants of the Russian Fund for Basic Researches (RFBR), Russian Scientific Fund, "Federal target programs". Now submission of requests for such grants is automated and is carried out entirely on the basis of ICT usage. Let's mark that grants on carrying out joint surveys with foreign scientists of different countries are systematically provided by the RFBR. But there are no foreign Caspian states among such countries, as a rule. (5) The competition for receiving grants on holding scientific actions: conferences, seminars, schools for youth and so forth. Receiving appropriate money resources for regional universities can be rather essential in the financially. Let's emphasize that so far the RFBR supports only actions with internal participation of researchers. However the distant involvement of some speakers in real time isn't excluded – the modern ICT allow to provide such involvement in full, including presentations demonstration, responses to the questions and so forth (6) Intraregional competition of universities can also take place in the relation of grants, provided by the regional governments for carrying out researches of "local" character. However in present time funds for such purposes are allocated not in all Russian regions and not every year. (7) Competition for obtaining orders for execution the commercial works in the interests of different organizations – regional and extraregional. (8) Competition in the field of scientific journals issuing, attraction in them competent members of editorial boards, authors and groups of authors. University journals are the important means of promoting in scientific information space of conducted researches results (Alt2011); establishments of communications between universities, certain researchers and their groups. The materials, published in Russian universities journals are reflected at the website www.elibrary.ru; in the database of the works, available via the search engine on www.scholar.google and so forth.

Let's mark that ICT usage by authors strengthened the competition of scientific journals for qualitative articles, including competition with foreign editions. At the same time application of automated means of "loans checking" in the articles, represented by authors, allows to timely reveal plagiarism, including in the cases when technologies of "rewriting of texts" have been used. However such means of check are effective mainly for loans from Russian-language sources. In too time to reveal in the automated mode, "translated into Russian" loans from the articles, published in English in foreign journals, is rather problematic. Especially it belongs to articles, published in "east" languages. Their translation in an automatic mode is also possible with ICT usage, though provides the low quality texts, which require the subsequent stylistic editing. However for the purposes of deliberate use of loans it can be less important. (9) Competition, concerning opening and operation of Councils for theses protection. In this direction between regional universities take place processes not only the competition, but also cooperation.

Thus, universities of the considered Russian regions work in rather difficult, competitive conditions. Let's mark also that development of international relations of Russia, including formation and use of "transport corridors", objectively stimulates extension of foreign communications of Caspian Basin "regional" universities, including on the basis of ICT use.

Therefore for the universities, considered in this article, is very important the goal of competitiveness saving and improving providing. This goal can be reached by different by various methods application.

(1) At the expense of a dimple of cooperation of universities and scientific research institutes, including within bilateral interuniversity agreements; involvements in different consortia and associations of universities – including the Russian research and development organizations, foreign universities and so on. In Russian-language literature also the term "network interaction of universities" is used [Zbo17].

Composition of the main problems, which can be solved within interuniversity agreements and associations. (a) Coordination of undergraduate and students training, taking into account the developing needs of the countries and their certain regions; organization of teachers exchange between universities on the temporary basis; the organization of training techniques exchange for the purpose of their enhancement. In too time interuniversity exchange of training materials require a certain unification of training technologies, studied disciplines composition, approaches to training and so forth (b) Implementation of joint separate scientific projects and programs (c) Preparation and holding joint scientific actions.

(2) By the extension of the international cooperation of universities – particularly, for attraction students from abroad on training; for involvements in "double diplomas" programs; students sending in the magistracies of foreign universities; reception "on training" students and undergraduates from abroad in the Russian universities and so forth. Let's mark that in this regard for universities in Caspian regions of Russia is important, first of all, cooperation with universities of the republics Kazakhstan, Turkmenistan and Azerbaijan – including because of

their proximity to this regions.

(3) Due to extension of contacts with the Russian organizations (enterprises) in regions of locations and other regions of Russia. The possible work purposes by this direction. (a) Support of students with places of practice, and graduates – with places of employment. (b) Adjustment of working programs of training under requirements of potential employers. (c) Attraction of financing from the organizations (enterprises) by signing of the contracts on execution the commercial researchers (works).

For all these three directions use of ICT plays a key role However appropriate questions in literature are probed insufficiently fully. It concerns, in particular, questions of creation and use of information systems, the systems of remote learning, the universities websites and so forth. Let's emphasize that the websites of universities can be considered not only as means of information dissemination, but in some cases and as subject to "competitive investigation" of other organizations.

Mandatory requirements to the websites of the Russian universities are set by the Ministry of Education and Science of the Russian Federation. These requirements are concerned with composition of the placed information, a completeness of "disclosure" for information about universities activities. These mandatory requirements are usually observed by Russian universities, but the considerable part of data on the websites are placed "over" these requirements. Besides, it is possible to note insufficiently regulation for questions of the universities websites information security at the normative level.

2 Task

A main purpose of this article is the complex analysis of opportunities and restrictions of ICT use for support of interaction between Russian universities, the academic organizations, manufacturing enterprises; with foreign universities and other organizations. At the same time certain emphases are placed on the following questions: use of ICT for support of the modern pedagogical technologies, directed to activation of "do-it-yourself" students activities, the adaptive control of the contents and complexity of training materials; support of information security of ICT-usage, taking into account opportunities of the hacker attacks on universities information systems, distant learning systems and websites; the features of decision making (and implementation) on ICT development, connected to specifics of Russian Caspian regions.

3 Development Of Methodology

3.1 Materials, Used For Research

When carrying out researches, described in this article, authors have been used materials from different sources [Mar18]. (1) First of all the materials from the websites of the universities, located in Caspian regions of Russia. (2) Websites of the Russian regional Ministries of Education, Foreign economic activity and so forth. (3) The news messages available on different websites, including the websites supporting the "printing mass media". (4) The reference information, posted on the website of the Russian statistics committee and on websites of its regional subdivisions. (5) The materials of scientific publications, available on the website www.elibrary.ru, www.scholar.google.ru, the foreign websites, including the international abstract bases and systems of citing accounting (including for publications in SCOPUS, Web of Science, etc.).

Also the personal experience of authors, gained in the course of work in Astrakhan region state bodies, was used; in educational and research establishments of this region.

3.2 Methodic Of Research

For information search different options of requests were applied to Internet search engines (mainly have been used Google and Yandex). When operation with electronic repositories of scientific information regular retrieval means of appropriate resources were applied; the extended information selection opportunities given by them. Also the "Dubl-GIS" system was used – in it changes on the universities, located in Astrakhan, Elista, Makhachkala, are rather quickly made.

The composition and volume of probed information was defined based on the principle "need and sufficiency" for the complete analyzing of questions, reviewed in this article.

When processing of assembled information methods of systems analysis were applied.

4 Results

Some data concerning levels of a computerization of the considered regions are available in collections of the materials, published by the Russian Statistics Committee. However these data belong only to quantities of used "items of equipment", but not to regional volumes of Internet traffic; to the nomenclature of the used software, databases and so forth. In Internet there are available only data about organizations websites. Note that data about websites volumes, their attendance usually aren't published in Internet and in statistical collections.

The composition of the universities, their branches and representations in Caspian regions of Russia was defined – in recent years the composition of such organizations was stabilized. On the basis of the data, posted on the websites, also the set of the directions of training of students in the considered regions, was revealed – including in the ICT directions. However on the basis of information, provided on the universities websites, it is impossible to estimate the number of the students, who are actually studying on separate specialties; number of graduates and so forth.

On the websites of the Russian universities (at least, budgetary) there is also information about departments nomenclature; about "science schools" in universities; about compositions of departments teachers; about their directions of educational and scientific activities; about the advanced training courses, passed by teachers, the defended dissertations, about the received grants and other personal achievements. Also there is information on the scientific journals, published by universities and, usually, archives of numbers issued earlier. Detailed scientific indexes for journals, issued by the Russian universities, can be found on the website www.elibrary.ru.

In too time the considerable part of the information, connected with the current activities of universities, appears only for rather short time in news messages on universities websites homepages. Further this information can often be found only with using websites search engines on the.

The number of the scientific articles, relating to social and economic processes in the considered regions, is rather high. However among them there are very few publications in which the questions of universities activities, their interactions with other organizations are raised; also the uses of ICT for support of such interactions.

5 Discussion

So, as main purposes of ICT usage in the considered universities we will select the following: direct support of educational process, including concerning with the use of innovative technologies, the systems of distant education and so forth; support of carrying out scientific research (means of information, program and technical support); monitoring and control of printing activity of universities employees and students; support of financial and economic activities of universities; support of the decision of the tasks, connected to human resources management in the universities; information and advertizing support of attraction students in universities on training and so forth; development of interactions with other Russian universities [Yak10], including "extraregional" organizations (in this regard universities with the special legal statuses can play a special role – the national research universities, the federal universities); communications with other external organizations – Russian and foreign, including with use of "technological frameworks" [Akp17, Sov16], ; communications with the natural persons, working out of universities; development of the international humanitarian relations of universities in the sphere of culture, sport and so forth, including within border cooperation [Ruz16] with other Caspian countries; obtaining necessary statistical information and forecasts, concerning universities activities – including for acceptance and implementation of pro-active solutions; development (enhancement) of material and technical resources of ICT use in universities; enhancement of the nomenclature of the software, used, including made by universities independently and also available to free use under the Creative Common licenses.

To the provided list of "purposes" it is expedient to make the following notes.

(1) Maintenance only of the Russian-language websites of the Russian universities considerably restricts their popularity in Internet space; possibilities of use not by Russian-speaking users in foreign countries. However in the republics Kazakhstan, Turkmenistan, Azerbaijan most of the population can work with the Russian-language websites without use of Internet translators. In too time for many other countries it is expedient to have foreign-language pages of the universities websites with the minimum volume of content. In addition it will provide detection of such pages by robots-crawlers of the appropriate search engines and, as a result, output of links to such pages in the search queries made by users in the appropriate national languages [Vas2017]. In particular for the websites of universities of Russia Caspian regions it may be expedient to use foreign-language pages not only on Farsi, the Kazakh, Azerbaijani and Turkmen languages, but also on some other – including Turkish, Arab, Hindi, Chinese. It will provide not only the current communication of universities in Caspian regions, but also some perspective (for example, connected to development of the Caspian Sea "international

transport corridors”, extension of multimodal transportations and so forth). Also are interested the questions of technologies of automatic ”connection” of Internet translators usage for processing the Russian-language Internet pages, opened by foreign-language users on the websites of the Russian universities.

(2) In the simplest case within activities of associations (consortia) of universities, sets of hyperlinks to the websites of other universities- members of such associations, can be posted on their websites. However in connection with large volumes of the information, placed on the majority of the universities websites, such hyperlinks can be hardly noticeable. Therefore also there are effective the different approach – creation of the separate multilingual websites for the specified associations of universities. Due to use structured (and annotated) sets of hyperlinks to the websites of universities-members such ”superlinear” websites will perform the doorway function. Let’s emphasize that considered references can leads not to the homepages of universities-members, but can be used as “functional objects”. For example, they can be connected with Internet-pages, related to separate directions of universities educational activities, scientific research and so forth. As information on such websites will seldom change (and also in small volumes), costs of the current maintenance of such websites-doorways will be small in comparing with main universities websites [Gal2009].

It is expedient to organize switching between languages on the homepages of the multilingual websites by means of buttons with images of national flags for those countries on which languages switching is necessary. In addition, under appropriate buttons is rational to place the name of national language, written on its national alphabets. Use of such decision (especially in case of large number of languages) will provide rather convenient possibilities of switching for Internet-users.

(3) Within creation of associations (consortia) of universities due to use of ICT the partial integration of their resources, intended for use in the educational purposes, can be carried out. For this purpose geographically distributed banks of educational, methodical and control test materials can be created. At the same time possibilities of mutual access to such materials can be regulated by special interuniversity agreements [Kon17].

In the general case the model of the universities mutual access to the resources, intended for collective use, can be presented in the form of a square matrix

$$[\mathbf{D}_{i,j}]_{i=1 \dots N, j=1 \dots N} \quad (1)$$

In this matrix lines correspond to those universities, which assign access rights to their resources. The columns of matrix $[\mathbf{D}]$ – to those universities, for which such access rights are assigned. It is supposed that access to resources (only intended for collective use) assign universities-owners of resources or their representatives in the associations.

The resources, intended for collective use, can be the separate ”objects” on universities servers, which are specially intended for external access. In the technical plan (and also for the reasons of information security) such solution can be more convenient. However it usually leads to ”duplication” of already available resources, placed on universities servers. The set of the resources, intended for collective use and placed on different universities servers, maybe considered as the ”geographically distributed” database. We will note that for use expansions for ”resources, intended for collective use”, the corresponding materials can be translated into English.

Elements of matrix (1) in the simplest case can be of type ”1” (there is an access to resources) and ”0” (there is no access). The formula (1) describes only the simplest model. However different access rights to resources are usually necessary for different categories of natural persons. In particular for universities teachers access to methodical materials, and for students – to test materials can be necessary. (Questions of accumulation and the analysis of such testing results in the universities or inter universities databases need separate discussion). Besides, concerning access rights to resources it is reasonable to set some ”time intervals” – generally they can also be different for different types of resources and user groups. Therefore the model of a task of access to resources, described by a formula (1), generally should be complicated and presented, for example, in the form

$$[\mathbf{D}_{i,j,k,l,m}]_{i=1 \dots N, j=1 \dots N, k=1 \dots K, l=1 \dots L, m=1 \dots M} \quad (2)$$

where: N– total number of universities, which are members of associations; K- total number of resources types, intended for mutual (collective) access; L - total number of natural persons types categories; M– total number of types of actions, which the specified categories of natural persons can “make” with this resources.

In particular, can be made such actions: acquaintance with methodical or training materials; passing (execution) of testing; other active usage of control training systems resources; commenting of resources (for example, training material)s and so forth.

Let's emphasize that in the equation (2) are used "types of resources" and "groups" of natural persons. However if necessary also "objects" like "separate resources" (for example, training courses) and "certain natural persons" can be considered. At the same time in typical cases it is supposed that the rights for correction of resources (their change, addition and so forth) can have only universities-owners of resources. In other words in typical cases for a task of such rights adjustment only elements of a matrix (2) with equal values "i" and "j" can be used.

At the described approach in cages of the matrix, described by formula (2), "intervals on time", concerning with access rights are established, have to be placed. In the simplest case it have to be pair of parameters like "date and time", setting the beginning and the end of the only time interval. However in general case such time intervals maybe not the single and it will demand more complex decisions on placement of information, concerning with a task of access rights assignment and algorithms for this information processing.

Let's note also that use of matrixes (2) for a task of the rights assigning demands observance of special measures of information security – since this "matrix" generally can be placed out of Internet resources of concrete universities. In particular special "procedures of confirmation" have to be provided for any corrections of this matrix elements; structure of categories of users, for which are given rights access; structure (set) of their possible actions; time intervals for access to resources and actions with them. For support of such confirmations decisions on the basis of "cryptographic protocols" can be used, for example.

In case of "unequal deposits" of participating universities to banks of resources, some interuniversity payments, including the considering actual demands of the placed materials, can be provided.

Use of the described banks potentially allows to achieve the following purposes: extension of most demanded educational resources, which can use universities – including within remote learning processes; unification of approaches of universities to students training, to estimation of training results. Last goal can be reached, for example, by mutual "blind" audit of control and test materials, developed by different universities.

(4) In comparison with the leading universities of Russia [Sor2017] development of the international cooperation of "regional" universities from Caspian regions of Russia has the considerable specifics. This specific are concerned with the purposes of regional universities (usually they have more "local" character) and volumes of resources, available for them. At the same time purposes of interuniversities communications development have to BE coordinated with development of international relations of regions.

The separate purpose (to be exact – for group of the purposes) it is necessary to specify the solution of information security problems ensuring for the information resources, which are saved up by the universities. These objectives are achieved due to use in universities of the following means: special software with the centralized updated viruses scripts databases; uses of protection means for information, posted on the universities websites; monitoring of "protocols" of access to sites; preliminary monitoring of the materials, published in universities journals and other editions; maintaining confidentiality of materials, used for requests for obtaining patents for inventions, requests for grants, for competitions and so forth. In certain cases to this list have to be added also providing of confidentiality for the results of scientific research– at least before publication of such results in the open access sources. Let's mark that information security of universities is ensured by program means usage; preparation and support of necessary conditions of activities for the profile specialists; by the ensuring of general ICT-competence of universities teachers and other staff [Kuz12, Kuz14].

As the main technologies (directions) of ICT use in universities it is possible to mark the following: development and use of information systems and also separate subsystems for these systems; creation and use of systems for remote learning and/or knowledge testing; acquisition and installation on universities personal computers and servers of "ready" program technical means with different function; independent development of special software for support of educational process and scientific research for support of universities activities; formation and updating of different databases, used in universities information systems, on their websites; development and use of universities own systems of e-mail, including for systems intended for intrauniversity usage; development and use of the universities websites (generally there can be more than one website); use of program-technical means for a video conferencing providing (for the educational and scientific purposes).

Note, that there are some problems with e-mail usage in universities, concerned with information security problems [Set99].

Below we describe a model for expenditures optimization by the separate directions, relating to the using and/or planed "technologies".

Lets present criteria function (G) for this model in the form

$$G = f(x_1 \dots x_Q) \quad (3)$$

where: Q – is the number of goals (purposes); $x_1 \dots x_Q$ - values of dimensionless indexes of these goals achievement. Assume, for simplicity, that all indices in (3) may be only positive and the greater values of indexes are preferable.

Let's accept for (3) additive model

$$G = \sum_{q=1}^Q w_q (x_q - x_q^*) \quad (4)$$

where: $\{x_q^*\}_{q=1 \dots Q}$ – the set of some “base” values for indexes. In general case this “base values” are different for different goals (purposes). Suppose, that values $\{x_q^*\}$ can be evaluated by experts. During this evaluation may be taking into account the actual indexes values; normative values for some indexes; indices of values in rival universities etc.;

$\{x_q^*\}_{q=1 \dots Q}$ – “planned” values of indices.

In some cases values of $\{x_q\}$ and $\{x_q^*\}$ can be calculated – for example in the relation of ICT hardware. In other cases they can be estimated by experts (groups of experts).

For determinacy we will assume that values $\{x_q\}$ and $\{x_q^*\}$ can be in an interval “0... 100” units. So when $x_q > x_q^*$ contribution of the q-index in criteria function G is positive, when $x_q < x_q^*$ – the contribution is negative.

In (4) $\{w_q\}_{q=1 \dots Q}$ is the set of dimensionless weight factors, which shows importance (for the G-value) of indexes, connected with separate purposes. Assume, that values of $\{w_q\}$ are evaluated by experts.

As a generalization of (4) can be written

$$G = \sum_{q=1}^Q w_q^\# (x_q - x_q^*) \quad (5)$$

$$w_q^\# = \begin{cases} w_q^+ & \text{if } x_q > x_q^* \\ w_q^- & \text{if } x_q < x_q^* \end{cases} \quad (6)$$

Thus the positive and negative deviations x_q from x_q^* will have different ponderability, concerning with the contribution to the target function in (5).

Achievement of “indexes values” (corresponding with goals) is provided by usage of some ”expenses”. We will use matrix $[E]$ (rectangular), in which lines correspond to the indices (related to the “goals”) and columns – to the “directions of expenses”, related to the “technologies”

$$[E_{q,b}]_{q=1 \dots Q, b=1 \dots B} \quad (7)$$

where: Q – number of goals; B – number of “directions of expenses” (technologies).

Assume, that $E_{q,b}$ is the value of difference for “q” index, corresponding to the “unit of cost” usage by the b-direction. Thus expenses by each direction can result in effects (usually they are positive) to one or more indices.

As the optimized vector of expenses by the directions (technologies) we will accept $\{Z_q\}_{b=1 \dots B}$. For accounting of cumulative influence of the specified “costs vector” to the “set of indexes” we use a formula

$$\{x\} = [E] \{Z\} \quad (8)$$

where in the right part of a formula (8) multiplication is executed by the rule ”line” on the ”column”; $\{x\}$ - is the “vector-column” of indices. This calculated indices $\{x\}$ are used together with formula (5).

When expenses optimization it is necessary observance of some additional restrictions.

Restriction on total costs - ”in general” (Z^{max}) and by the “separate directions” (Z_b^{max})

$$\sum_{b=1}^B Z_b \leq Z_b^{max} \quad \{Z_b \leq Z_b^{max}\}_{b=1 \dots B} \quad (9)$$

Restrictions on minimum permissible values for separate indexes $\{X_q^{min}\}$

$$\{X_q \geq X_q^{min}\} \quad (10)$$

Note, that “level of information security” can be one of indices in (10).

As the additional restrictions may be need to consider volumes of resources, available for usage – including labor recourses, floor areas at the universities and so on.

The formulas, given above, describe problem definition, which can be referred to the class of linear programming tasks.

Receiving solutions for the presented optimization task can be implemented, for example, with use of means "Solution Search" which is available in Microsoft Excel. In addition this program means gives the opportunity to estimate "stability" of the received optimal solution by the input data.

Note that significant simplification of the described model is absence of account for delay of the received results in the relation to the made expenses.

6 Conclusion

Development of ICT considerably affects to the technologies of training, applied in universities; to the methods of carrying out scientific research and approaches to publication of their results in journals and other editions; to the internal organization of universities activities. Development of interuniversity communications the ICT usage provide the following opportunities: facilitation of universities-partners (Russian and foreign) search for cooperation and other purposes; establishment and maintenance of communications with them – mainly in electronic form; extension of exchange for organizations experience, concerning with educational process and scientific research. Besides, development of ICT provides convenient possibilities for formation of the "technological frameworks", important for establishing and maintenance communications of universities with other types of the organizations, potential employers and so forth.

At the same time development of ICT strengthens the information competition between universities in Internet space; requires timely detection of cases of appearance on the Internet (including social networks) unreasonable negative information about universities, timely acceptance of adequate responses to such information. Development of ICT in universities demands the considerable expenditures on measures of information security support. It is essential that these measures should consider not only the current types of threats, but also those which can arise in the future. It especially concerns the large volumes of information, accumulated in databases of information systems and also on the websites of universities. It is expedient to use complex of the technologies described above; when they potentially allows to provide some synergy effects.

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