

# Dynamic Prediction Model Reproduction of Human Resources of the Information Technology Industry

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## ABSTRACT

The article deals with the problem of forecasting the demand for qualified personnel in the information technology industry. Movement of personnel potential of the industry organizations and universities considered in terms of continuous training workers. The article deals with the basic regulatory parameters that affect the stability of the frame reproduction system in the industry. We describe the relationship between educational structures, the labor market and potential employers. The university is considered from two perspectives - as a source of reproduction of human resources and as an employer. Describes different scenarios of the development process.

## Keywords

Training; professional education, qualifications; Labor Demand, Mathematical Methods, Model, Dynamic Analysis

## 1. INTRODUCTION

The modern development of information technology (IT), a complication of manufacturing processes change approach to understanding the problems with formation of personnel potential in IT-industry. Professional training of specialists depends on the quality of their training, but also on the professionalism and qualifications of teaching staff. So, the solution to the problems with formation of personnel potential in the industry is inextricably linked with the objectives of reproduction and development of human resource capacity vocational training.

To solve the problem of shortage with highly qualified specialists in the teaching staff of universities the process of formation of human resources should be based on analysis of the current staffing situation and planning prospects for its reproduction. Workforce planning defines competitiveness of the organization, enabling its staff to solve production problems at the right time, in the right quantity, and with the appropriate skills. Planning for staffing requirements is also linked to determine the demand for their additional training if their professional knowledge and skills are not matches to goal of organization's strategy (in the present period and in the future).

The particular importance in career planning employee in organization attached to the formation of personnel reserve, that would be ready in terms of experience, qualifications of a specialist to replace the employee at a higher position, able to quickly learn a new work area. In this regard, the career must be managed, organized and justified in advance, usually for a period of training of personnel reserve. Time is an important factor for training and improvement of skills of personnel reserve for their new work. The need for personnel reserve should be calculated before the occurrence of changes in the organization's strategy. This requires planning and forecasting methods to the evaluation of professional qualification and age structure of staff.

## 2. THE MODEL OF THE SYSTEM OF REPRODUCTION OF PERSONNEL POTENTIAL IN THE IT INDUSTRY

Updating vocational and professional staffing structure can be determined by the analysis of demographic processes, economic conditions, changes in technology and the technical level of production, industry challenges, social mobility of workers.

From the point of view from the reproduction of human resources capacity in the IT industry, it is important to establish and analyze the interaction of the elements in reproductive processes of the organization in the IT industry, universities and the labor market (jobs that do not require IT competencies). It is important to investigate in detail the process of personnel potential replenishment in each researched object (IT organizations, universities and the labor market) and to determine the direction of structural optimization through the use of simulation methods. It is important to identify sustainable trends in quantitative indicators characterizing the reproductive system of personnel potential in the IT industry. We need to use a dynamic approach to forecasting for solving of these tasks.

The model of the system of reproduction of personnel potential in the IT industry is based on determining the prospects for supply and demand of number of employees who has specific skills in IT and in IT training. The task is in order to identify their deficit or surplus in the future. However, this task requires compliance with the requirements in resource provision to meet demand in IT specialists and teachers in the university. It is important to keep balance between the needs for skills and capabilities of vocational education. We understand that the educational process, first of all, must be provided with high quality teaching staff, the potential of which should be promptly replenish and maintain the proper level of quality and quantity.

Developed earlier macroeconomic forecasting models staffing needs in the regional economy did not take into account the rates and level of development in the IT industry, the labor market and the country's population, age related changes of employers and staff in the university, the need to support a high level of qualification of teaching staff in the university. Also, it does not address the needs of high school in the reproduction and improvement of skills, which vary with time, and, unfortunately, in recent years - not for the better. Aging of workforce and the reluctance of young scientists to improve skills (who do not have sufficient financial resources and motivational reasons to continue research activities for the degree of Doctor of Sciences) determined prospects for reducing the qualification level of staffing of higher education. You may determine the forecast in demand on the number of frames on the near horizon, but at the same time it is important to assess whether there is a human resource for its preparation.

Presented to discussion method of solving the problem with forecasting the demand of employers for qualified professionals takes into account the movement of personnel as a result of changes in the vocational qualification and age structure in the university staff and the IT organization - a partner university. It takes into account the training of personnel reserves for the IT organization. That such changes as the aging workforce and leaving of personnel who is over 70 years; staff turnover; the need growth in the number of specialists for solving of industrial tasks in future; change the qualification level of the employee; the outflow of workers from the IT industry to another industry that does not require IT skills, for example - in the case of higher salary. Avoid the risk of "collapse" in the qualification and age structure of the objects will allow prospective determination of its critical areas and timely training.

The developed model of the system of reproduction of personnel potential in the university and the organization of the IT industry is represented by three units of qualifications. The flow movement of subjects in cases of their continuous training and their career, respectively, determines these units. Unit 1 - the low-level managers are in IT organization and graduates, teachers without a degree are in a university; unit 2 - the middle-level managers is in IT organization and PhD are university; unit 3 - the top management is in IT organization and doctor of sciences are university. The main difference between the proposed approach to the formation of prediction models staffing situation and planning personnel reserve is a mathematical description of the relationship with the two entities - the organization of the IT industry and the university, carrying out targeted training for the reproduction of human resource capacity of the IT organization and the university itself. Each of the objects, in turn, is seen as a complex system consisting of reproduction units, determining levels of qualification personnel. Each reproduction unit evaluated in terms of the interaction in the IT industry and universities in the conditions of continuous professional training of IT specialists, administrative staff in IT organization and the teaching staff of universities. Reproduction of frames is based on respect for the principle of qualification development and career development of personnel reserve, which will keep the experience, knowledge of IT organization and of universities.

Each unit consists of a reproduction of educational stages training - training in high school (baccalaureate, and master's specialties), postgraduate or in the business of education and doctoral studies. Reproduction frames of each unit is due to the increase the skills of its employees in the education system, university graduates (specialty, undergraduate, graduate, postgraduate and doctoral programs), as well as in the event of a shortage - due to the labor market. Evaluation of the reproductive system of human resource capacity of the university and its partner (IT organization) suggests research of moving frames vertical (skill levels) and horizontally (outflow and filling frames). Deficit reduction of personnel shall be at the expense using its own internal resources. It is caused primarily for the preservation of traditions and the intellectual potential of the organization. The surplus fills labor market. Deficit of receiving the education system - specialty, undergraduate, graduate, postgraduate and doctoral courses for business education program Master of Business Administration (MBA) and Executive Master Business Administration, (EMBA) - compensated by external personnel reserve.

Let us consider in detail one unit reproduction of human resources.

**The university is a training system.** Bachelors, Graduates of the Specialists' programme and Masters swell the

number of Low-level Managers and certified specialists of IT industry through 4, 5 and 6 years, respectively. Graduates of the Specialists' programme and Masters swell the number of Assistant professors through 5 and 6 years, respectively too. Some Bachelors will continue their undergraduate education in magistracy. Some Graduates of the Specialists' programme and Masters will continue their education in graduate school. If there is a surplus on training of specialists, they go the labor market to search for vacancies. And this is not IT-vacancies.

The training involves loss. The model takes into account the respective trends in performance training, the volume of admission to the first year, the rate of change of the demographic situation in the country.

#### **The university is an employer.**

Completion of the fourth frame of the university qualifications sectoral framework (teachers without a degree) is due to Graduates of the Specialists' programme and Masters.

Some Assistant professors move into the category of candidates after defending his doctoral dissertation. We're considered trends of employee turnover, aging staff, changes in the number of teaching staff in our model.

#### **IT-organization is an employer.**

Filling the IT organization staff (Low-level Managers and certified specialists) is due to Graduates of the Specialists' programmer, Masters and Bachelors. Some specialists after training in MBA will be taken to the next level.

#### **Labor market.**

If Graduates of the Specialists' programme, Masters and Bachelors are unclaimed at the university and the IT organization, they will seek employment in the labor market. Interest in employment not in the specialty can cause a higher level of wages in the other sector of economic. This is reason for an outflow of personnel from the IT industry and the university. The labor market supplies frames to the university and the IT industry in the event of a shortage of internal reserve for reproduction.

### **3. THE PRINCIPAL FEATURES IN THE DEVELOPED MODEL**

When calculating the number of staffing should take into account the horizontal change (staff outflow, loss of students at every level of education) and the vertical - the number of employees, who will move to other units of our model when it will have next level of qualification.

The main key indicators of regulation in the reproduction process of personnel potential in the IT industry (KPI) are the number of admissions to Bachelors, Masters, Specialists' programme, post-graduate, doctoral, MBA and EMBA; productivity of training; work experience (in informal learning); turnover of staff and aging (outflow) personnel at all skill levels; advanced training by additional training, which determines their career; changes in the number of personnel by increasing staffing needs of different qualifications; changes in the demographic situation in the country.

To be able to assess and make timely adjustments in management staff in the IT organization and the university allocated additional sustainability indicators of human capacity of reproduction by internal human resources: the motivation factor for graduates for further training in graduate school; the indicators of employment of graduates in the University to address the deficit of teachers in university; the index advanced training of staff of the university and the organization of the IT industry; the indicators of the attractiveness of the labor market in case of excess the growth rate of wages in the labor market in comparison with IT industry (it is losses of training); the deficit of personnel

reserves of the organization of the IT industry and university. The analysis of these indicators is aimed on identifying the nature of the change of number and qualifications of human resources of IT organization and university. And also this analysis help to mark effect of using of internal staff reserves (number and qualifications) when we manage to reproducing of human resources.

The principal features in the developed model are:

1) The influence of demographic, economic and social factors on the structure of training.

2) Isolation of the key indicators of regulation of reproduction with the preservation age and skill mix of the university and enterprises of the IT industry.

3) Development of scenarios, including consideration of changes in the demographic situation, increase the number of budget places for the elimination of skills shortages, targeted training in partnership with companies, employers, development of the IT industry (increasing demand for IT specialists) changes in wages board of experts in the IT field and other industries.

The model is implemented in a computer systems simulation Anylogic University 6.9.0 [1]. The main elements of these system-dynamic models are storage and flows of analyzed data. The system dynamics storages are used to represent these objects in the real world in which the focus some resources - in this case, the number of certain categories of workers. The storages set a static state of the modeled system. Their values changes over time in accordance with the existing system flows. Thus, the flow set dynamics of the system. A feature of all qualification levels of the model is the presence of flow "Deficit" and "Surplus" and the implementation of feedback.

In the formula given by the flow number, formula or function that reflects - how many units of storage in a single model of time (one calendar year) pass through this stream. The formula of the flow indicates that in Masters came students who successfully complete the training in a bachelor degree, taking into account the average coefficient of admission. These factors can be modified in the parameters of the model to test the response of the system of reproduction of human capacity in the IT industry various trends. According to statistics processed and calculating the coefficients in the model are listed formula to determine the number of units the reproduction process.

For analysis of the system response to changes in its parameters was performed seven launches model scenarios with varying one or more variables. As the impact of various scenarios on a system of indicators of reproduction human capacity were analyzed: scenario of rapid growth and decline in the development of the industry; the scenario of "aging" industry personnel; scenarios reduce the number of entrants and the judiciary increasing demand of employers for Masters; demographic scenario of falling and growth. The results of the experiments, including alleged positive dynamics of development of events showed the prospect of continuing shortage of teaching staff of universities and IT personnel.

The developed model allows to determine the need for replenishment of the staff of the enterprise IT industry and the university, a plan for training and retraining of personnel reserve and thus increase the effectiveness of official promotion specialists and managerial staff organizations and universities. Formed a set of key sustainability indicators of the reproduction of cadres of the enterprise IT industry and the university is required to ensure the timely adjustment in the control system of qualified personnel in the organization of the university and industry to assess their effectiveness. The model will ensure the balance and the linking of all parties planning staff, to avoid distortion

of vocational structure of the personnel of the IT industry and the university, as well as the loss of professional skills, time and production capabilities, reduce the time and cost of training professionals to increase productivity and quality their work.

The presented method allows abstracting from the large number of variables that characterize the considered sophisticated facilities management, to take into account the main factors affecting the conservation and replenishment of personnel potential of the IT industry. Model of forecasting the demand for qualified professionals can serve as tools for decision-making in change management professional qualification and age structure of the personnel and the organization of the teaching staff of the university, including solved by the introduction of quotas to regulate the direct allocation of jobs to young specialists, targeted training. Conducting experiments on the model will trace the responses of human capacity of reproduction on quantitative changes of its parameters; determine how the potential number of staff specific skills will have an organization for solving the tasks set for the future, at any given time; assess the need for and the possibility of training for the timely maintenance and development of its human resources; identify bottlenecks in the reproduction process.

As a result of the scenario study projected staffing situation, reproduction of the IT industry can determine critical areas of age and qualification structure of staff in organizations and universities, to evaluate the possibility of training and retraining of personnel in the universities, to generate an optimal plan for training of personnel reserve in conditions of high returns from vocational education. Methods of systematic and comprehensive reproductive management personnel potential in the IT industry provides:

- organization of a stable and continuous reproduction of specialized professionals and managerial employees of the industry, as well as the faculty of colleges on the basis of sectoral activities to attract and retain talented young people in the industry;
- improvement of professional qualification and age structure of organizations IT industry and higher education institutions through targeted training and improvement of qualification of specialists;
- regular monitoring of the IT industry organizations and universities on key parameters of reproduction of human resources;
- scientific justification for taking timely measures to improve the skills of employees, their target training in industry schools on the basis of features of computer mathematical modeling, forecasting tools, scripting staffing situation and planning staff of enterprises (organizations) of the IT industry and universities;
- improving the quality of vocational education and its relevance to the needs of the labor market and modern qualification requirements;
- the possibility of expanding the boundaries of the use of research results by forming a strategic partnership model of university and industrial companies in various fields of training, retraining and advanced training of specialized professionals and managers.

## REFERENCES

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