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IMPROVING LEGAL REGULATION EFFICIENCY OF PERSONNEL NUMBER OPTIMISATION USING MATHEMATICAL METHODS

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Abstract

The necessity to optimize the number of employees is conditioned by a number of objective factors and is connected with possible negative consequences for the employees working under the labor contract. Consequently, a number of rules aimed at the employees' protection shall be enacted. The process of optimizing the employees' number is also due to enterprise quantitative characteristics, some of which shall be improved (labor productivity, production rate standards) and others shall be reduced (payment costs, etc.). Accordingly, business inquiries into the optimal number of employees are necessary to ensure organization work. To solve the problem of optimal planning of employees' number for the planning period, it is possible to use various mathematical methods, which become particularly relevant when business management is becoming more and more digitalized. In crisis situations, the issue of optimizing the number of employees is particularly vital; as a result, the main approach to regulating the number of employees from the employer's perspective is to minimize the number of employees and reduce the cost of their maintenance. However, headcount reduction by means of layoffs, including those caused by job elimination, inevitably leads to many negative social consequences. The increasing use of mathematical calculations aimed to determine the optimal number of employees requires staff organizational measures. These circumstances call for more effective legal regulation to protect the rights of redundant employees. The authors formulate proposals aimed to improve legislation bearing in mind the specifics of personnel number optimization processes.

Keywords: Digitalization, headcount optimization, legal regulation, mathematical methods, personnel management, staff reduction

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1. Introduction

The task of human resource management is an integral part of any organization work. Proper workforce management in any organization is essential for the development of the entire business.

The term “workforce optimization” has been widely used by managers since the 1990s, when there was a production decline and many industrial enterprises faced financial deterioration.

In 2020, infection wave brought new constraints and regulations into public life and the issue of headcount optimization was back on the agenda, with many employers forced to rethink their HR policies and generate resources in difficult socio-economic times.

In general, the need for periodic staff optimization measures is due to a number of reasons, including the legislation status (tax, labor, social relations); the objective need to reduce costs, including staff costs; organizational changes, business process optimization; production diversification; and economic and state regulation changes.

2. Problem Statement

Various mathematical methods are used to solve the issue of optimal headcount planning for the planning period (Suvalova, 2017). It is not possible to develop a universal way of solving this problem, because it is multi-criteria, and the criteria vary depending not only on the type of organization, but the type of activity as well. There are many headcount planning software packages out there, but each one shall be adjusted and add new blocks developed for each individual organization. For smaller workforces, this can be done using functions and other features of multi-tasking spreadsheets, such as Microsoft Excel.

This paper considers the process of solving a particular problem of planning the number of employees for a given time period using dynamic programming method and proposes the development of a program to conduct automatic calculations leading to a numerical solution to the problem, as well as identifies methods of innovative technologies for using optimization methods by managing employees.

Logically, the use of mathematical methods for calculating the optimal number of organization staff results in setting the task of improving legal regulation efficiency by identifying the regulations to be adjusted and fixing new provisions that take into account the need to protect labor and social rights of employees, organizational and staffing measures being adopted.

3. Research Questions

Dynamic programming is a mathematical instrument that approaches the solution of some optimization problems by decomposing them into smaller and less complex problems. A distinctive feature of this solution is to carry out calculations step by step, which is typical for dynamic programming. The main idea of that method is to solve optimization problems including a large number of variables and constraints by subdividing them into subtasks containing just a few variables each, with solution of the overall problem to follow.

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In general, the mathematical apparatus can be viewed as step-by-step or progressive programming. The planning of each step should consider the overall benefit obtained at the end of the whole process, which optimizes the final result in accordance with the criterion chosen.

The general problem statement of dynamic programming is as follows. A controlled process is considered, e.g. it can be allocation of funds between enterprises, use of resources over a number of years, replacement of equipment, restocking, scheduling the staff, etc. Being controlled, the system (control object) is sequentially transferred from the initial state ξ_0 into the final state ξ_n. Suppose that the control can be divided into n steps, and the decision is made coherently at each step, and the total control is a set of n step-by-step controlling actions. At each step, two types of variables need to be defined – the system state variable ξ_k and the control variable x_k. Variable ξ_k determines which states the system may have at any k-step in question. Depending on the state ξ_k in this step, some controls including the variable x_k can be applied, and are known as admissible controls.

The specific features of dynamic programming mathematical model are as follows:

- the optimization problem is formulated as a finite multi-step control process;
- the performance or optimality criterion of the operation is defined by a target function which is an additional function of each optimization step. That is

$$F(x) = \sum_{k=1}^{n} f_k(\xi_{k-1}, x_k);$$

- the choice of x_k control point at each step depends only on the state of the system ξ_{k-1} by that step and has no effect on previous steps (no feedback);
- the state of the system ξ_k after each control step depends only on the previous state of the system ξ_{k-1} and the control action x_k (no feedback following) and can be written as the system state equation

$$\xi_k = \varphi_k(\xi_{k-1}, x_k),\ k = 1, \ldots, n;$$

- at each step, the control x_k depends on a finite number of controlled variables, and the state of the system ξ_k depends on a finite number of parameters;
- the optimal control is a numerical vector X*, defined by a sequence of optimal step-by-step controlling points: $X^* = (x^*_1, x^*_2, ..., x^*_k, ..., x^*_n)$, the number of which determines the number of steps in the task.

The tasks solved by the dynamic programming method, among others, include the task of finding an optimal employee allocation plan for different working periods (Shorikov & Filippova, 2017).

Two types of measures can be distinguished in personnel deliverance planning:

- Measures that do not reduce the number of employees in the organization;
- Measures aimed at reducing the number of employees. Accordingly, reactive and anticipatory staff deliverance are distinguished (Pogodina, 2013).

Reactive personnel deliverance is used only when it is necessary to get rid of surplus labour force within a short period of time. This includes, above all, layoffs. Downsizing through redundancies,

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however, is extremely traumatic for the organization and inevitably leads to all sorts of costs, including litigation expenses.

Early personnel deliverance is based on demand for personnel forecasts, including those modelled by mathematical calculations, and uses rather soft methods and means, allowing timely staff reduction through natural or mutually beneficial processes and thus avoiding layoffs. The second option is more acceptable and indicates well-managed staffing.

The most promising approach to avoid redundancies is to manage staff numbers and costs without redundancies.

The measures that allow rational use of the available staff and, accordingly, cost-cutting without staff reduction, include reduction of overtime hours; taking no new employees; prohibition of internal secondary jobs; intra-organizational and structural transfers of employees; use of flexible (non-standard) employment forms, such as part-time jobs (subemployment), temporary (casual) employment, and distant work.

Measures to optimize the employees' number within anticipatory deliverance may include:

- Incentives for early retirement of employees;
- Encouraged dismissal of pension-age persons through special benefits;
- Incentives for voluntary redundancy (significant bonus being paid to them), etc. (for instance, Moroz, 2007).

Based on personnel need forecasts, the organizations should carry out personnel deliverance.

4. Purpose of the Study

The purpose of the research is to determine applicability of mathematical methods and computer calculations to solve the problem of optimizing the number of employees and thereby improve the legal regulation efficiency through strengthening legislation in deterring labor and social staff rights' violations.

5. Research Methods

The researchers used the comparative mathematical analysis method aimed at headcount optimization. Comparative legal method, empirical (analysis and synthesis, induction and deduction, systematization) and theoretical methods (methods of research object construction and research and methods of theoretical knowledge construction and reasoning) were also used in this research.

The solution of a specific task of optimization of the number of teachers involved in the educational process is based on the optimality principle first defined by the American mathematician R.E. Bellman: whatever the system state as the result of any number of steps is, at the closest step we should choose the controlling option, so that together with the optimal control at all subsequent steps it leads to the optimal result at all the rest steps, including the result at this step.

The process of solving the problem by dynamic programming method is two-stage: conditional and unconditional optimization. The first stage is performed in steps when the process starts with the last n-th step with consecutive transitions to the first step. At each step of any state of the system ξ_{k-1} the

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solution x_k must be chosen "with caution", since this choice affects the subsequent state ξ_k and further control process. This follows from the optimality principle. But there is one step, the last one, which can be planned for any state ξ_{n-1}, based only on observations received at this step. Conditional optimization step of the dynamic programming method includes sequential solution of Bellman equations on each step starting with the last one and finding conditional optimal values of the objective function $Z^*_k(\xi_{k-1})$ and corresponding conditional optimal control $x^*_k(\xi_{k-1})$ for each step. On the last step of the conditional optimization when n is equal to 1, since the system state is defined uniquely and coincides with the initial state ξ_0, it is necessary to determine the only value $Z^*_1(\xi_0)$ and the only optimal control at this step $x^*_1(\xi_0)$.

After the stage of conditional optimization, in order to find the solution to the problem it is necessary to follow with unconditional optimization that is the second step of the dynamic programming computational scheme. At this stage, if the optimal value of the function $Z^*_1(\xi_0)$ is known, we turn to the sequence of variables $x^*_k(\xi_{k-1})$ starting with $x^*_1(\xi_0)$ and sequentially passing to the end value $x^*_n(\xi_{n-1})$..

6. Findings

For efficient headcount nowadays, it is necessary to use computer calculations. When solving such problems using the programming method, it is more convenient to record the results of calculations in tables. To automate the solution of this problem, a software product was created using the widespread spreadsheet software Microsoft Excel. The software product is an Excel program file with macros support, and the automation of calculations is implemented using the built-in Microsoft Excel functions and program codes created in the Visual Basic Application programming environment, which design is described thoroughly in the article of one of the co-authors (Arkhangelskaya, 2019). The information resource is organized in such a way that in order to solve the above described problem with specific numerical data, the user needs to input the number of employees necessary at each stage of the planning period into the Excel cells.

The proposed model allows forecasting the situation of staff requirement and timely preparing for organizational and staffing measures, including rational use of human resources and headcount optimization.

Legal regulation of these processes is necessary because social, among them labor rights, shall be recognized as a constitutional value and be protected. Accordingly, the labor legislation should enshrine the mechanism for systemic protection of employees' rights during headcount optimization periods. In particular, it is necessary to establish the norm according to which local acts of the organization and/or collective labor agreement shall approve rules on the headcount optimization procedure in case of significant redundancies, guarantee that the rights of transferred or dismissed employees are respected, and provide incentives for voluntary dismissal.

In particular, in connection with intra-organizational transfers that require a change of profession or mastery of multi-skilled professions, an employment contract shall include the provision on training of an employee at the employer's expense.

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In addition to the benefits provided by law, organizations may decide to use their own funds to pay a number of compensations to support dismissed employees. Support for laid-off workers can be provided, first of all, through compensation by the enterprise for job loss; assistance in finding a new job; psychological adaptation to job loss conditions (Moroz, 2007).

7. Conclusion

The toolkit proposed in this research can be used for staff scheduling in an organization and in training courses for learning dynamic programming techniques in order to optimize the staff number within an organization.

The advantages of the software product created are as follows: compactness of results displaying numerical calculations on the screen and the fact that a user needs only to click two functional buttons in Excel spreadsheet in order to get the solution for the task: "Make calculations" to display numerical values received on each conditional optimization step and "Get the solution" to display optimal number of employees the organization needs.

The functionality of the two buttons can be combined into one, but the organization of the work with two buttons has an educational and methodological purpose to familiarize the users with the steps of solving a problem using dynamic programming method. This development can be used as an e-learning tool. The program code can be modified quite easily and the input data can be set with random numbers. It is also possible to organize problem statement for specified number of n periods, for this purpose the number of periods should be set in a separate cell, and all calculations should be performed for specified number of steps.

Headcount planning is part of workforce planning and therefore is an area of employer's responsibility. Optimizing the organizational structure of an enterprise always involves approving a new staff schedule and conducting organizational staff meetings. The employer is authorized and is able to change the staff schedule at his or her discretion, either by increasing or decreasing the number of employees working under an employment contract.

The applicability of mathematical methods seems to be a good method to determine the optimal number of employees in the organization. At the same time, some mechanisms aimed at observing the rights and interests of employees in internal regulations of the organization are essential.

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