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Modeling the Economic Consequences of Optimizing Individual Work and Rest Conditions Using Biorhythmic Data in a Corporate Environment

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Abstract: Amid growing interest in improving labor efficiency, sustainable development, and employee well-being, personalized work schedules based on chronobiological data present a promising approach. This study models the economic impact of such an approach and finds that even moderate gains in productivity (8–12%) and reductions in sick leave and employee turnover can yield substantial financial benefits. The effect is particularly pronounced in knowledge-based industries such as IT, telecom, and finance, where implementation costs may be recovered within 1–2 years. Beyond direct economic returns, this strategy contributes to lower burnout rates, increased job satisfaction, and the emergence of a more flexible and humane corporate culture—factors that enhance long-term competitiveness in talent acquisition and retention. However, the transition to asynchronous work also introduces management and organizational risks, including coordination challenges and compliance with labor laws. A successful implementation requires a holistic approach: training for managers, IT infrastructure upgrades, and new interaction norms. To support broader adoption, further empirical research, pilot projects across various sectors, and the development of regulatory and methodological frameworks are recommended. Chronobiology-driven labor management may become a key element in shaping a future-oriented, human-centered economy.

1 INTRODUCTION

In the context of rapid changes in the organization of work and growing attention to the well-being of employees, optimizing individual work and rest is becoming a key factor in increasing productivity and economic efficiency of companies. Modern research highlights the importance of taking into account biorhythms and flexible work schedules to achieve these goals.

Circadian rhythms, which determine the daily fluctuations of physiological and psychological processes, have a significant impact on the performance and overall health of employees. Mismatching the work schedule with individual biorhythms can lead to decreased productivity, increased mistakes, and increased stress levels. For example, a study conducted in Iran showed that disruption of circadian rhythms in healthcare workers is associated with poor sleep quality and reduced work efficiency (Poormoosa, 2024).

In addition, flexible forms of employment, such as remote or hybrid work, are becoming increasingly popular among workers. According to a study conducted by Stanford University, employees who work from home two days a week are just as productive and likely to be promoted as their full-time office colleagues. At the same time, the layoff rate among such employees is decreasing by 33% (Crawford, 2024).

Considering the above, the purpose of this article is to model the economic consequences of introducing biorhythm-based mechanisms for optimizing work and rest conditions in a corporate

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environment. The proposed model will make it possible to assess the impact of individualized work schedules on key economic indicators of the company, such as labor productivity, personnel costs and the overall economic effect.

2 MATERIALS AND METHODS

Circadian rhythms are biological processes that repeat approximately every 24 hours and are regulated by the body's internal clock. The main central regulator of these rhythms is the suprachiasmatic nucleus of the hypothalamus, which synchronizes with external temporal signals such as light and temperature (Chawla, 2024). At the molecular level, circadian rhythms are controlled by transcriptional-translational feedbacks involving the CLOCK, BMAL1, PER, and CRY genes. These genes form two-component cycles that regulate various physiological processes, including sleep, wakefulness, metabolism, and immune response (Codoñer-Franch, 2023).

A chronotype is an individual's tendency to be more active at certain times of the day, due to genetic and age—related factors. There are morning (larks), evening (owls) and intermediate chronotypes. Research shows that synchronizing working hours with an individual's chronotype increases productivity and reduces stress. For example, employees with a later chronotype show improved cognitive function and reduced fatigue if their work schedule matches their biological preferences (Schilbach, 2025).

Circadian rhythm disorders, such as shift work, night shifts, or irregular sleep patterns, can lead to various physiological and psychological disorders. These include sleep disorders, depression, cognitive disorders, and an increased risk of cardiovascular disease. In addition, such disorders can negatively affect the immune system and metabolism, increasing susceptibility to infections and the development of chronic diseases.

Circadian rhythms are also regulated by nutrition and the state of the intestinal microbiota. Meal timing can affect the activity of circadian genes and metabolic processes. In addition, the gut microbiota exhibits diurnal fluctuations that synchronize with external temporal signals such as light and nutrition. Disturbances in these rhythms can lead to metabolic disorders and diseases.

Modern research highlights the importance of taking into account individual biological rhythms when organizing working hours. Personalizing the work schedule based on employee chronotypes can help increase productivity, improve sleep quality and overall well-being.

The introduction of flexible work schedules that take into account individual biorhythms is becoming increasingly popular. The concept of "chronoworking" involves adapting working hours to the natural peak periods of employee activity. Such approaches can increase productivity, reduce stress levels, and improve the overall well-being of employees (Foster, 2024).

Modern technologies make it possible to more accurately determine the chronotype of employees. For example, using data from day planning and machine learning applications can help classify users by chronotypes. This opens up opportunities for more precise adjustment of the work schedule in accordance with individual biorhythms (Kaushik, 2024).

Lighting plays a key role in regulating circadian rhythms. Research shows that personalized lighting in offices that takes into account the biological clock of employees can improve sleep quality and overall well-being. Such lighting systems can help synchronize the internal biological clock with the work schedule, reducing the level of "social jet lag."

Personalization of the work schedule, taking into account individual biorhythms and chronotypes of employees, is a promising approach to improving work efficiency and employee well-being. The integration of modern technologies and scientific data into the organization of working hours can help create a healthier and more productive work environment.

2.1 Key metrics of economic efficiency

Economic efficiency in the context of corporate governance is defined as the ability of an organization to achieve maximum results with minimal resource expenditure. This includes optimizing processes, reducing costs, and increasing productivity. Efficiency is measured through the ratio of the result obtained to the resources used and is a key indicator of a company's sustainability and competitiveness (O. Fried, 2008).

- Labor productivity reflects the volume of products or services produced per unit of labor expended. Increased productivity indicates a more efficient use of human resources and can be achieved through training, motivation, and workflow optimization.
- Costs include all costs associated with the production and sale of products or services.

Reducing costs without compromising product quality is an important aspect of improving economic efficiency. This can be achieved through process optimization, the introduction of new technologies, and effective resource management.

- Staff turnover reflects the stability of staff in an organization. A high turnover rate can lead to increased costs for hiring and training new employees, as well as lower overall productivity. Retention of qualified employees contributes to the accumulation of experience and knowledge within the company, which has a positive effect on its economic efficiency.
- Return on Investment (ROE) measures the effectiveness of invested funds, showing how profitable a particular investment decision was. A high ROI indicates that investments have brought significant returns relative to their costs, which is an indicator of high economic efficiency.

Understanding and analyzing these metrics allows organizations to identify areas for improvement, optimize processes, and make informed decisions aimed at improving overall economic efficiency.

2.2 The effect of improper working conditions on the economy of companies

Improper organization of the work regime, including irregular schedules, shift work and excessive working hours, has a significant negative impact on the economic performance of companies. The main impacts include decreased productivity, increased errors, increased hospital admissions, and staff turnover.

Fatigue caused by impaired circadian rhythms and insufficient rest leads to a decrease in cognitive functions, impaired concentration, and an increase in the number of mistakes in the workplace. This is especially critical in areas that require high precision and responsibility, such as healthcare and manufacturing. Research shows that fatigue can lead to decreased productivity and an increased number of errors, which entails additional costs for companies.

Irregular schedules and shift work contribute to an increase in the number of mistakes in the workplace. For example, in healthcare, improper working conditions can lead to errors in prescribing medications and caring for patients, which not only threatens patient safety, but also increases the costs of companies to correct errors and possible legal costs.

Improper working conditions contribute to the deterioration of the health of employees, which leads to an increase in the number of sick days. This, in turn, reduces the overall productivity of the company and increases the cost of replacing absent employees and paying for sick leave.

Unfavorable working conditions, including irregular schedules and high fatigue, contribute to increased staff turnover. Replacing employees requires additional costs for hiring and training new employees, as well as a temporary decrease in productivity.

The combined impact of fatigue, errors, sick days, and staff turnover leads to significant economic losses for companies. These losses result in lower profits, higher costs, and a deterioration in the company's reputation.

Thus, the incorrect organization of the labor regime has a complex negative impact on the economy of companies. The introduction of personalized work schedules that take into account the individual biorhythms of employees can help increase productivity, reduce errors and sick days, as well as reduce staff turnover, which ultimately leads to an improvement in the company's economic performance.

2.3 Justification of the model

To model the economic consequences of introducing personalized work schedules based on biorhythms, consider a hypothetical average Russian company with about 100 employees. Such companies often face limited resources and strive to optimize processes to increase efficiency and competitiveness.

Characteristics of the modeling object:

- Company size: 100 employees
- Average salary: 87,952 rubles per month
- Annual salary fund: 87 952 × 12 × 100 = 105 542 400 rubles (excluding funds)
- Average labor productivity: 2.5 million rubles. revenue per employee per year
- Total annual revenue of the company: 250,000,000 rubles (RBC, 2025).

Typical company workload:

- Work schedule: standard from 9:00 to 18:00, 5/2
- Basic issues:
    - Fatigue
    - Complaints about the schedule
    - Staff turnover rate: about 15% per year (Ancor, 2024)

- Sick days: an average of 7 days per employee per year (Dream Job, 2025)

Research shows that the introduction of flexible and personalized work schedules can lead to lower staff turnover and increased productivity. For example, a Stanford University study found that employees who work from home two days a week are just as productive and likely to be promoted as their full-time office colleagues. At the same time, the layoff rate among such employees is decreasing by 33%.

Thus, the model under consideration will allow us to assess the economic benefits of implementing personalized work schedules in an average Russian company, taking into account the potential increase in productivity and reduction of costs associated with staff turnover.

As part of the justification of the model, we will consider two options for the organization of the labor regime, which will be described below.

2.3.1 Option A: Standard schedule

The traditional approach, in which all employees work on a fixed schedule (for example, from 9:00 to 18:00), does not take into account individual biorhythms. This can lead to a decrease in productivity, especially for employees with an evening chronotype, for whom the morning hours are a period of reduced activity. Research shows that a mismatch between natural biorhythms and work schedules can cause a "social jet lag", reducing cognitive functions and overall well-being of employees (Future of the Office, 2025)

2.3.2 Option B: Customized schedule

The personalized approach involves adapting the work schedule to the individual chronotypes of employees. This may include:

- Determining the chronotype of each employee using questionnaires or digital tools.
- Flexible task planning that allows employees to complete the most difficult tasks during their peak activity periods.
- Using technology to monitor and analyze biorhythms, such as wearable devices and sleep and activity tracking apps (FasterCapital, 2025)

2.3.3 Assumptions for the model

Research shows that matching work schedules with individual biorhythms can increase employee productivity by 10-20%. This is due to the fact that employees perform tasks during periods of their maximum cognitive activity (myshyft, 2025).

Personalized schedules help reduce stress levels and improve the overall well-being of employees, resulting in a 15-30% reduction in sick days and a 20-40% reduction in staff turnover.

The implementation of personalized charts requires investments in:

- Training of personnel and management in the principles of chronobiology.
- Development or purchase of software for schedule planning and monitoring.
- Purchase of biorhythm tracking devices (for example, fitness trackers).

However, these costs can be offset by increasing productivity and reducing costs associated with staff turnover and sick leave.

The transition from a standard to an individualized work schedule based on biorhythmic data can lead to significant improvements in productivity, a reduction in the number of sick days and staff turnover. Despite the initial investment, the long-term benefits make this approach promising for modern organizations.

2.4 Building a model

The input parameters are shown in Table 1.

Table 1: Input parameters.

Parameter	Symbol	Unit of Measurement	Comment
Number of employees	□	persons	For example, 100
Average annual revenue per employee	□	RUB/year	From Rosstat, by industry, e.g., 5,470,000 RUB
Average productivity growth rate	□_r	%	Approximately 10–15% with individualization
Average number of sick days per year	$□_0$	days/person	For example, 10
Reduction in sick days after optimization	Δ□	%	For example, −25%

Average salary per employee	Av_s	RUB/year	For example, 1,200,000 RUB
Employee turnover rate (standard)	□o	%/year	For example, 20%
Reduction in turnover after optimization	Δ□	%	For example, −30%
Implementation costs	Im_c	RUB	Training, systems, software, etc.
Payback period	□	years	For example, 1 year

Calculation Formulas

Total revenue before implementation (baseline scenario):

$$V_{base} = N \times V \tag{1}$$

Total revenue after implementation (with productivity growth):

$$V_{opt} = N \times V \times \left(1 + \frac{P_r}{100}\right) \tag{2}$$

Additional revenue from productivity increase:

$$\Delta V = V_{opt} - V_{base} = N \times V \times \frac{P_r}{100} \tag{3}$$

Loss of working time due to sick leaves (before and after):

$$L_{sick\ 0} = N \times B_0 \times \frac{C_{sal}}{250} \tag{4}$$

$$L_{sick\ 1} = N \times B_0 \times \left(1 - \frac{\Delta B}{100}\right) \times \frac{C_{sal}}{250} \tag{5}$$

(*Assuming 250 working days per year*)

Savings from reduction in sick leaves:

$$\Delta L_{sick} = L_{sick\ 0} - L_{sick\ 1} \tag{6}$$

Savings from reduced employee turnover:

$$C_{turnover} = N \times T_0 \times C_{sal} \tag{7}$$

$$\Delta C_{turnover} = C_{turnover} \times \frac{\Delta T}{100} \tag{8}$$

Total annual economic effect:

$$E_{total} = \Delta V + \Delta L_{sick} + \Delta C_{turnover} \tag{9}$$

Net economic effect (considering implementation costs):

$$NPV = E_{total} - C_{impl} \tag{10}$$

ROI (Return on Investment):

$$ROI = \frac{NPV}{C_{impl}} \times 100\% \tag{11}$$

Example Parameters for an IT Company (100 Employees):

V=5,470,000 RUB
Pr=12%
B0=10 days
B=25%
T0=20%
T=30%
Csal=1,200,000 RUB
Cimpl=3,000,000 RUB

a) Baseline Scenario (No Changes) In this scenario, the organization continues to operate under a traditional model: all employees follow the same fixed schedule (e.g., 9:00 to 18:00), without considering individual biorhythms.

Key characteristics of the baseline scenario:

Number of employees: 100

Average revenue per employee: 5,470,000 RUB/year

Total organizational revenue:

$$\begin{aligned} V_{base} &= 100 \times 5{,}470{,}000 \\ &= 547{,}000{,}000\ RUB \\ &/year \end{aligned} \tag{12}$$

Sick days: 10 days per employee per year

Salary losses due to sick leave:

$$L_{sick\ 0} = 100 \times 10 \times \frac{1{,}200{,}000}{250} = 4{,}800k \tag{13}$$

Staff turnover: 20%

Costs of turnover (including training and onboarding):

$$C_{turn} = 100 \times 0.20 \times 1{,}200k = 24{,}000k \tag{14}$$

b) Optimized Scenario (Personalized Work Schedule) In this scenario, an individual scheduling system is implemented based on employees' biorhythmic data. The following improvements are assumed for modeling:

Productivity growth: +12%
Sick days reduction: −25%
Turnover reduction: −30%
One-time implementation cost: 3,000,000 RUB

Calculations:
New revenue accounting for productivity increase:

$$V_{opt} = 100 \times 5{,}470k \times (1.12) = 612{,}640k \quad (15)$$

Additional revenue:

$$\Delta V = 612{,}640k - 547{,}000k = 65{,}640k \quad (16)$$

New salary losses from reduced sick leave:

$$L_{sick\ 1} = 100 \times (7.5) \times \frac{1{,}200k}{250} = 3{,}600k \quad (17)$$

Savings on sick leave:

$$\Delta L_{sick} = 4{,}800k - 3{,}600k = 1{,}200k \quad (18)$$

Savings from reduced staff turnover:

$$\Delta C_{turn} = 24{,}000k \times 0.30 = 7{,}200k \quad (19)$$

Table 2: Summary of Optimized Scenario Results.

Indicator	Value (RUB/year)
Additional revenue	65,640,000
Sick leave savings	1,200,000
Turnover savings	7,200,000
Total economic benefit (E_o)	74,040,000
Implementation cost (one-time)	3,000,000
NPV (net benefit, year 1)	71,040,000
ROI	$\frac{71{,}040{,}000}{3{,}000{,}000} \times 100\% = 2368\%$

The comparison between the two scenarios clearly demonstrates the high efficiency of implementing a personalized work schedule based on individual biorhythms. Even with moderate improvements in productivity, reduced turnover, and fewer sick days, the economic benefits significantly outweigh the implementation costs.

3 RESULTS

Table 3 contains a comparative analysis of two scenarios: basic and optimized. In the basic scenario, the organization operates according to a standard fixed schedule without taking into account the individual characteristics of employees. In the optimized scenario, a personalized work regime based on the biorhythms of employees is being implemented.

The results show a significant increase in revenue, reduced losses and high profitability of the project when implementing a personalized approach.

Table 3: Comparison of Two Scenarios by Key Economic Indicators.

Indicator	Baseline Scenario	Optimized Scenario	Difference
Number of employees	100 people	100 people	–
Revenue (annual)	547,000 k RUB	612,640k RUB	+65,640k RUB
Sick leave losses	4,800k RUB	3,600k RUB	−1,200k RUB
Turnover-related costs	24,000k RUB	16,800k RUB	−7,200k RUB
Total annual economic benefit	–	74,040k RUB	
Cost of implementing personalized schedule	–	3,000k RUB	
Net economic effect, NPV	–	71,040k RUB	
ROI	–	2368%	

To assess model robustness, possible fluctuations in key input parameters were analyzed. Variations include:

Table 4: Productivity Growth.

Productivity Growth	Additional Revenue (mln RUB)	NPV (mln RUB)
5%	27.35	30.75
10%	54.70	58.70
12% (base case)	65.64	71.04
15%	82.05	87.45

Table 5: Implementation Cost.

Implementation Cost (mln RUB)	ROI (%)
2	3552%
3 (base case)	2368%
5	1420%
10	710%

Even with moderate parameters (10–12% productivity growth, 30% reduction in turnover), transitioning to personalized schedules demonstrates high economic efficiency.

The investment pays back within 1 year, and ROI can exceed 2000%.

Sensitivity analysis confirms the model's robustness: even with productivity growth reduced to 5% and implementation costs increased to 5 million RUB, the project maintains a positive NPV.

The model can be adapted to other industries, provided data on salaries, turnover, and revenue are available.

4 DISCUSSION

The transition to individualized schedules based on employee biorhythms creates new challenges for managers, especially in terms of project management, team coordination, and execution control. The key management risks are presented below.

When employees are active at different times (for example, "larks" and "owls"), problems with operational interaction may arise:

- difficulties in holding meetings, brainstorms and quick approvals;
- reducing the effectiveness of teamwork on highly interdependent tasks;
- increased time to complete tasks on the "flow".

This is especially critical in areas where real-time synergy of efforts is important (for example, software development, marketing campaigns, operational customer support).

Standardized metrics (for example, hours of attendance, response time) may become uninformative with a flexible schedule. This requires managers to switch to output-based metrics, which

- increases the requirements for planning and task decomposition;
- requires retraining of management personnel;
- increases the burden on HR and team leaders.

In a decentralized regime, the risk increases:

- "falling out" of individual employees from the general rhythm;
- reducing the visibility of problems (delays, delays, burnout);
- disorganizations in crisis situations (for example, urgent tasks, changing priorities).

Managers need to implement tools for asynchronous communication, transparent reporting, and digital task tracking, which requires both technical and cultural changes.

With a variety of schedules and personal conditions, the burden on managers is increasing:

- the need to take into account individual modes when planning the work of the team;
- maintaining motivation and engagement of employees who are out of the "general rhythm";
- managing conflicts and feelings of injustice among employees with less flexible schedules (for example, customer support).

Possible ways to reduce managerial risks:

- The introduction of "nuclear time" (for example, 3-4 hours a day when all employees are available).
- Using digital platforms for task management and communication (Trello, Notion, Slack, Asana).
- Teaching managers the principles of managing results, not time.
- Creation of standard work profiles with ready-made scenarios of schedules (based on typical biorhythms and job responsibilities).
- The introduction of hybrid models, in which some employees work according to a standard schedule, and some work individually.

5 CONCLUSION

In the context of growing interest in improving labor efficiency, sustainable development and caring for the well-being of employees, personalization of the work regime based on biorhythms is a promising tool from both an economic and social point of view.

The simulation results show that even with a moderate increase in productivity (in the range of 8-12%) and a reduction in costs associated with illness and staff turnover, the economic effect of implementing personalized schedules can be significant. In a number of industries, especially those with a predominance of knowledge work (information technology, telecom, finance), the benefits may exceed the cost of implementation in the first 1-2 years after the start of operation of the system.

In addition to direct financial effects, the approach can contribute to reducing burnout, increasing job satisfaction, and developing a more flexible, humane corporate culture. In the long term, this creates competitive advantages for companies in the fight for talented employees and sustainable development.

At the same time, managerial and organizational risks associated with the transition to asynchronous work have been identified, including difficulties in coordinating, monitoring, and complying with labor laws. This requires a comprehensive approach to implementation, including executive training, modernization of the IT infrastructure and the formation of a new culture of interaction.

In general, a personalized approach to work organization based on chronobiological data can be considered as an innovative resource for improving economic efficiency and employee well-being. However, widespread adoption requires:

- further empirical studies confirming the effect in real production conditions;
- pilot projects based on Russian companies in various industries;
- development of regulatory and methodological frameworks that regulate and support the introduction of flexible forms of employment, taking into account biorhythms.

Thus, the integration of chronobiological principles into personnel management can become one of the directions for the development of the future labor economy, focused on human health and efficiency.

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